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ELY C. HUTCHINSON, *Editor*

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Don't Lose Your Job to Save Your Face

THE EDITOR has been favored by an interview with an engineer who applies his practical knowledge of the operation of steam plants and his ability to get the best results out of them to the supervision of plants that lack such expert oversight.

He gets his return in a percentage of the savings effected, and in general there is no difficulty in enlisting the owner's interest in an effort to improve conditions. The trouble comes in the antipathy if not the antagonism of the operatives.

These are, usually, just "hands." If they were competent engineers their administrations would leave no margin for the group operator. Such a supervisor fits in only upon jobs which are too small to warrant the employment of a qualified engineer or where the owner does not realize that the difference in the cost of operation under simple manual ability to keep things going and of technical ability to keep them going at the least cost would more than pay the price of the higher order of service.

Little sympathy as one may have with it, the attitude of the discredited operatives is not hard to understand. They are not always sensible of their limitations.

They claim that any reduction in expense gained by the intruder is gained by snapping the whip over them and by bleeding the plant.

To help him to demonstrate a big saving is to labor for his profit and that of the owner and for their own discredit.

Hence it is not surprising to learn of lack of sympathetic co-operation, of directions misapplied, of newly installed instruments and apparatus misused or disconnected, of the absence of effort to keep coal consumption and other costs down and even of willful waste and sabotage.

Shortsighted, of course. If their earlier practice had been directed by a loyal interest in the concern, by a realization that the security and importance of their jobs depended upon its growth and prosperity, if by knowledge acacquired and interest in its application they had got the most out of what they had to work with, no outside operator would have seen a profit in possible improvement.

If the men in the power house have not measured up to this, their failure to fall in with the methods of the supervisor and to reduce the power costs to the lowest terms will sacrifice the opportunity for self-improvement under competent instruction and may result in the determination by an owner, despairing of loyal cooperation, to abandon the plant and operate on purchased power.

F. R. Low

EDITORIALS

Buying Coal For Profit

IN THIS number appears the first of four articles on coal selection—unique in angle of approach, in sources of information, in competence of author, in dollars-and-cents value to the readers of *Power*.

The articles will reveal the great economic losses incurred by many a "model" plant in the blind competition for top efficiency. They will show that almost every coal market provides, for the shrewd buyer, "B.t.u. bargains" whereby he may save fifty cents or more per ton (on a heat-value basis) without sacrificing efficiency.

They will prove that the experience of a single plant or operator is not an adequate guide to such bargains, and that, more often than not, they will be missed if the search is conducted on the "try-this-or-try-that" plan. They will reveal a rational approach to the problem of coal selection, and will present case studies of plants which are saving many thousands of dollars yearly.

Finally, they will show how designers and buyers so misapply good equipment that it becomes a perpetual operating burden. Many a plant is thereby saddled with permanent coal-buying limitations whose capitalized value exceeds the entire investment.

These matters are of tremendous dollars-and-cents importance. They have never been adequately treated in any publication.

An Experiment In Technical Programs

MORE effective presentation of technical papers and the stimulation of their worth-while discussion are of deep concern to those charged with arranging programs. The problem is further aggravated by the general reaction that there are already too many meetings and too many papers.

Many factors enter into the success of a paper. In the first place, it should be written solely because it offers a contribution to knowledge on the subject and not to help fill a program. Secondly, it should be printed far enough in advance of the meeting to permit study by those qualified to offer discussion. And, finally, the author should present it, not in full, but summarized sufficiently to cover all important points. An experienced chairman may then be depended upon to bring out profitable discussion. These requirements are seldom fully met.

The first two factors are within the control of program committees, but few authors are capable of so abstracting their papers to cover the salient points and hold the interest of the audience. Fewer still are to be found among those qualified to speak authoritatively on technical subjects.

At the joint symposium of the A.S.M.E. and A.S.T.M. on Metals and Alloys at High Temperatures, at Chicago in June, an attempt will be made to meet this situation. The plan is to have the high spots of all papers at each session summarized by a committee representative, instead of authors presenting their own papers. The task of the representative will involve the presentation of a broad view of the subject, unencumbered by details, and the authors will merely answer questions from the floor.

The experiment is unique and will be followed intently.

Opportunity of the National Hydraulic Laboratory

BIDS ON the building and interior concrete work for the National Hydraulic Laboratory were opened by the Bureau of Standards in Washington, Monday, March 23, and the figures indicate the work will be done at a cost of approximately twenty-seven cents per cubic foot of building volume. This compares favorably with similar structures abroad, and indications are that an operating laboratory will be secured within the appropriation authorized by Congress.

The hydraulic plant will have a nominal capacity of two hundred fifty cubic feet per second, and its technical features show a gratifying grasp of the research and experimental requirements by the director, advisory committee and bureau staff.

At this time the selection of an outstanding hydraulic engineer to superintend the construction of the laboratory features and take charge when it is completed is important. It is assumed this man will plan the funda-

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mental research in which the laboratory will be so useful. He will also have a full program from such government departments as the Reclamation Service, Geological Survey, Bureau of Public Roads, and the army engineers as well. Although the engineer corps has its own laboratoroy at Vicksburg, it is primarily for river-training experiments, and no doubt the army will wish to take advantage of the national laboratory.

The extent of future usefulness of the plant will necessarily depend upon the development of a proper and constructive policy for its administration. It must not be operated in competition with the university laboratories already existing, nor in opposition to the purpose of the laboratories owned by leading manufacturers of hydraulic power machinery.

Hydraulic engineers generally have their eyes on the laboratory, and a great deal beside technical capacity depends upon the man who becomes its chief. It is fervently hoped that salary limitations will not prove to be a stumbling block. Capable men are not cheap.

High-Pressure Bleeder Heaters

WHEN bleeder heaters were first employed it was believed that it was not economical to bleed superheated steam. This idea was abandoned after careful calculations proved its falsity.

Next, it was held that superheat would seriously damage heater tubes and that bled steam must first be saturated in desuperheaters. Experience has indicated not only that no damage occurred to the heater tubes, but also that the rate of heat transfer was not materially altered by superheat.

It was also assumed that the condensate temperature leaving the last high-pressure heater must be from 5 to 10 deg. below the saturation temperature of the steam in the heater. It is said that some recent heater designs have the passes so arranged that the hottest condensate in the last pass before leaving the heater is surrounded by the entering bled steam, which is highly superheated The increased temperature head thereby made available has resulted, in certain cases, in raising the final feed water temperature up to or above that of saturated steam at heater pressure. Any such increase in the feed temperature from the last heater lowers the fuel consumption and improves station economy.

A gain of this order is so substantial that the additional cost, if any, of a heater specially designed to use this superheat is soon repaid. Furthermore, this added temperature is a further gain for the last bleeder heater, and under certain circumstances its savings through the utilization of the superheat to raise condensate temperature may warrant its use where economizers are not used.

These changing ideas indicate a definite trend toward simplicity in design, while a more thorough understanding of principles of heat transfer has improved the economic performance.

Load Requirements Determine Synchronous Motor Torque

SYNCHRONOUS MOTOR design in recent years has been the recipient of greater improvement than any other type. From a machine with generally unsatisfactory characteristics and very limited application it has been so improved that it now invades about every field where medium- and large-sized constant-speed drives are required. Although inherently a single, constant-speed machine, it has been applied to two-speed drives. Standard lines of synchronous motors have been developed that are interchangeable with general-purpose induction motors in sizes of twenty-five horsepower and above. Starting these motors has been made as simple an operation as for any other type. Notwithstanding these developments, there still remain in engineers' minds relics of a period when synchronous motors developed a poor starting torque.

Modern synchronous motors can be designed to develop a starting torque equal to that of any other type of alternating-current motor. This characteristic alone, however, does not insure a successful motor application. In selecting synchronous motors there are four torques to be considered, namely: starting, accelerating, pull-in and pull-out. The best of these cannot be combined in a conventional synchronous motor, and there are practically no applications where they are all required to be of a high value. For many applications it would be undesirable to use a motor that developed a high value of all four torques.

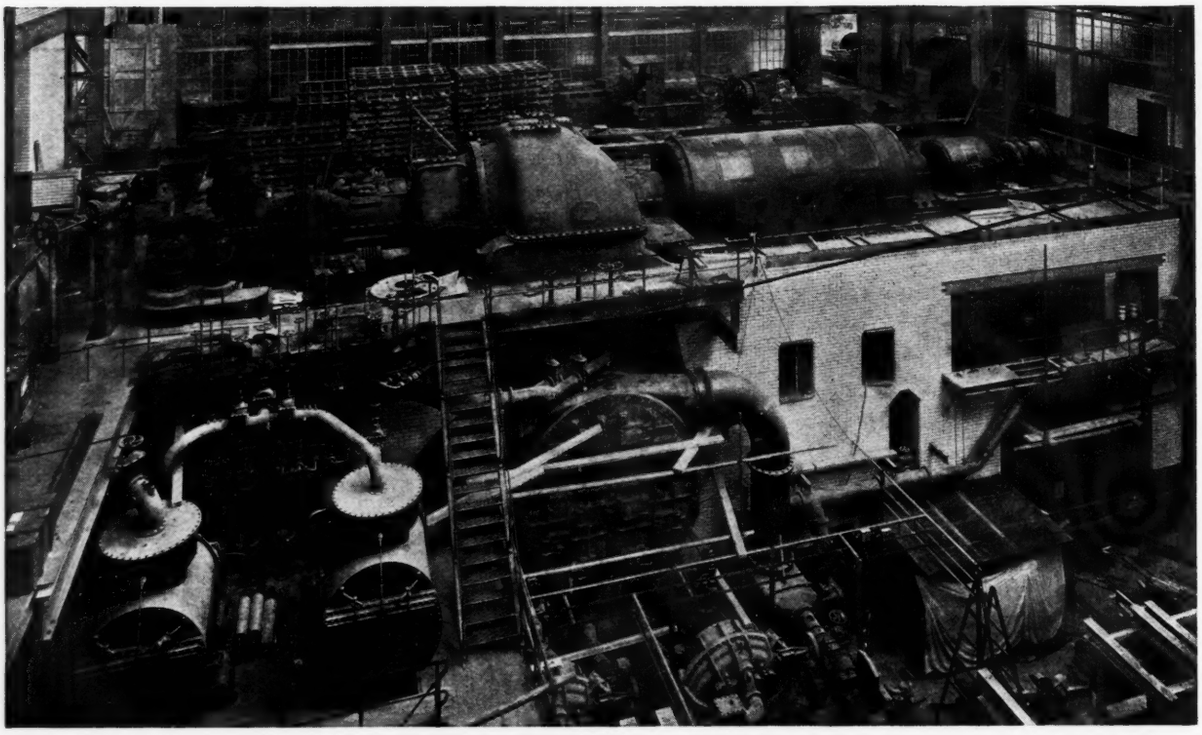
Moreover, a universal type of direct-current motor or induction motor has never been developed. These motors are designed for many different characteristic combinations to suit specific applications. It is generally recognized that a motor of the proper characteristics must be selected for a particular drive if a maximum of service at minimum cost is to be obtained. Likewise, with synchronous motors, a design must be chosen suited to load conditions. On a centrifugal pump high starting torque is not required, whereas on material-conveying and crushing machinery that may have to be started under overloads, high starting torque is paramount.

▼

POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

▼



First 50,000-kw. unit practically completed. Foundation steel for second appears in lower right-hand corner
All photos by Stewart Bale, Liverpool

British Super Station Rises at Clarence Dock*

THE CORPORATION of Liverpool is erecting a new super-power station destined to be one of the largest and most important power stations in England and one of the most efficient in Europe. It is being built under the provisions of the Electricity Act of 1926. Design of the station has been carried out by the city electrical engineer, P. J. Robinson, who has also supervised construction.

The steadily growing use of electricity in Liverpool has caused the Liverpool Electric Supply Undertaking to considerably increase its area of supply, which at present covers 87 square miles. Its output has increased to over 3½ times that of 1919, with a growth in maximum demand from 31,520 to 102,490 kilowatts. The following is based on information made public by Mr. Robinson.

Clarence Dock site was formally taken over from the Dock Board on March 26, 1929. Contracts for buildings and plant were placed during the following months, and at the present date, approximately two years after the taking over of the site, the station is practically ready for steaming.

The layout of the station is such that it will eventually contain eight 50,000 kw. turbine-alternators, two of which are now being installed, together with the necessary boiler and auxiliary plant. It embodies a number of interesting and unusual features (very large coal silo, for example), and has been designed throughout for reliability, high efficiency and simplicity of operation.

FEATURES

Ultimate capacity, 400,000 kw. in eight 50,000-kw. turbines. Stoker firing plus pulverized coal. Steam at 825 deg. 5,500-ton coal silo. Flooded coal storage, 30-ft. deep. Refractory-faced water walls. Cinder collector and chimney sprays. Condensing water settling chamber

While later some coal may be received by sea, a large proportion will always be brought by rail. Instead of relying on car dumpers, which are expensive to operate and entail delay in the handling of coal trains, provision has been made for the use of hopper-bottom cars of not less than 20 tons' capacity (greater than normal in England).

The sidings of the station are connected directly to the Dock Board main lines, which, in turn, are connected to the main railroad lines. Trainloads of coal of probably 450 tons will be brought direct from the M.D.H.B. lines over a coal silo capable of containing 5,500 tons of coal. These cars being of the hopper type, can be emptied very quickly and it

*Information supplied by A. C. BLACKALL, *Power* correspondent in London.

is not anticipated that it will take longer than 5 to 10 minutes to unload a complete trainload of coal.

This coal will be carried from silo to the boiler-house bunkers by belt conveyors. Coal can be delivered to the boiler house at the rate of 440 tons per hour.

In the later stages the station will consume about 5,000 tons of coal per day. Adequate coal storage must be provided and this is arranged for by reserving one half of the dock.

Many coals cannot be stored dry to a greater depth than 8 to 9 ft. without danger of spontaneous combustion. As, however, the dock is 30 ft. deep, the full depth will be available by flooding the coal store with sea water. A reinforced concrete retaining wall is being constructed to separate the coal-storage space from the building; 85,000 tons of coal can thus be stored without cutting away any of the dock walls, and this quantity can be increased to 110,000 tons by removing the existing wall of the dock as far as the corporation boundary.

A series of reinforced concrete gantries will travel over the coal-storage space over which the coal cars will be run and emptied, reclamation being carried out by grab cranes.

Stokers Plus Pulverized Coal

The station is laid out to contain, ultimately, 32 boiler units in four boiler houses. One boiler house is now being erected, but only four boiler units are being installed at present.

Each boiler will normally evaporate 160,000 lb. of steam per hour, generating steam at a pressure of 450 lb. and a temperature of 25 deg. F.

Each boiler unit consists of boiler, superheater mechanical stoker and pulverizing equipment, economizer, air heater, grit collector, forced- and induced-draft fans and chimney.

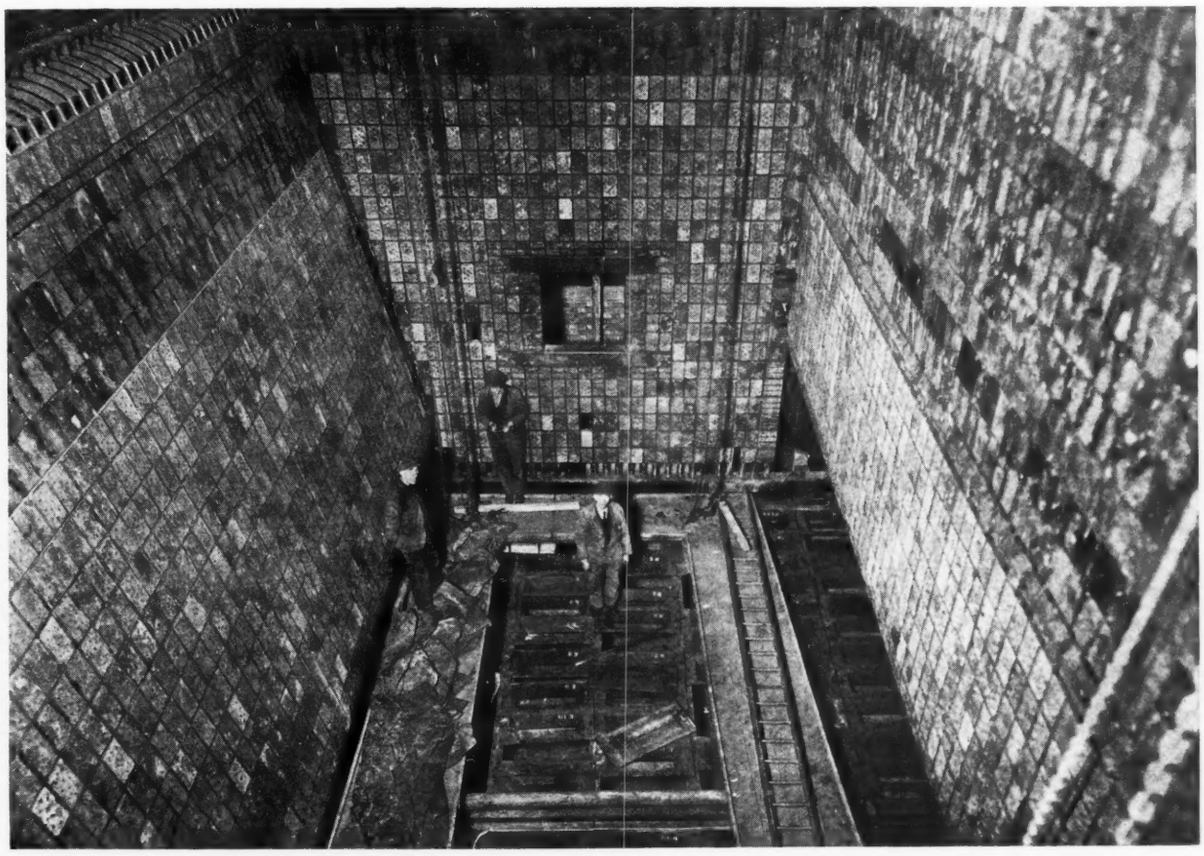
The coal normally burned will be "slack," fired on mechanical stokers of the chain-grate type, but pulverizing equipment is also installed as an auxiliary, suitable for burning either "slack" or "cutter dust." By the use of this pulverizing equipment it will be possible to increase the output of the boilers quickly when required.

With boilers running at high efficiency, and consequently high furnace temperature, upkeep of furnace refractories was, until a few years ago, a very expensive matter, but the adoption at the Lister Drive No. 3 station (Liverpool), for the first time in the British Isles, of cast-iron and refractory-faced walls proved so satisfactory that these have been adopted throughout the boilers at Clarence Dock. The tubes are covered with cast-iron blocks faced with refractory where the temperature is high, and bare cast-iron blocks where the temperature is low.

The chimneys are of a special design, patented by the city electrical engineer. They will remove not only any grit or dust in the flue gases which may escape collection in the grit catchers, but also any sulphur and deleterious fumes. The chimneys contain a system of fine and coarse sprays constructed of stainless steel.

Four boiler units will feed into each steam receiver and be normally associated with each turbine-alternator unit, but cross-connecting steam pipes are provided so that any turbine may be supplied with steam from any group of boilers.

The turbine house is 105 ft. wide, and the length of the present section is approximately 200 ft. The turbine-



After the first British experience with cast-iron and refractory-faced water walls at Lister Drive No. 3 station, this type of construction was adopted, as shown, for Clarence Dock furnaces

Settling chamber for the circulating water intake will remove much of the harbor silt

alternators are arranged crossways, with the turbines adjacent to the boiler house and the alternator adjacent to the switch house, so keeping to a minimum the lengths of both the steam pipes and the electrical connections.

Settling Chamber for Circulating Water

Condensing water is drawn from and returned to the River Mersey by reinforced concrete ducts, two inlet and two discharge ducts, each 6 ft. 6 in. by 6 ft. 9 in.

At the entrance to the inlet ducts on the river front is a large settling chamber, through which the velocity of the condensing water is so low as to cause most of the silt to deposit where it can be returned to the river.

With the exception of the emergency steam-driven feed pump all auxiliaries are electrically driven. In addition to the step-down transformers taking their supply from the main busbars at the station, each turbine-alternator is equipped with a special auxiliary alternator, and all important auxiliary motors can be fed from either of these two sources of supply.

Generation will take place at 7,300 volts, the pressure being raised by two transformers for each turbine-alternator unit to 33,000 volts, at which all switching is carried out.

The switch house runs parallel to the turbine house on the side remote from the boiler house and contains sixteen switches, each weighing approximately nine tons and having a rupturing capacity of 1,500,000 kilovolt-amperes.

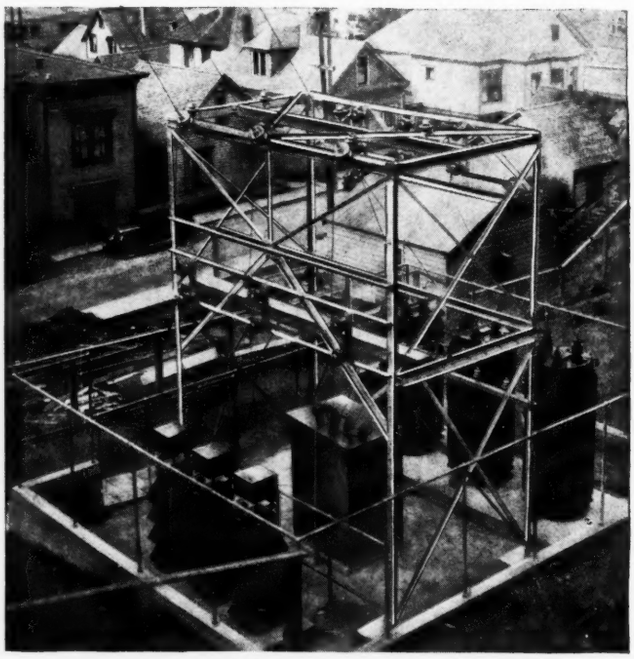
In view of the size of the station, it will be realized that the construction has been carried out with remarkable speed, and the work is one that is helpful in relieving the unemployment situation in Liverpool. Practically 4,000 tons of structural steel are already erected for the building.

Clarence Dock station and Lister Drive station will be operated entirely by the Corporation of Liverpool, but under the control of the Central Electricity Board, so the amount of energy generated will at all times be under supervision of the Central Electricity Board's engineers.

The cost of operation, including fuel and capital charges will, in the first instance, be paid by the corporation, but the board will purchase the whole of the output of the station, selling back to the corporation such proportions as will be needed for its own requirements.

It is obvious that the central board, in the endeavor to keep the cost of generation throughout the country to a minimum, will insist on as much energy as possible being generated in the most efficient stations. If, therefore, the Clarence Dock station proves to be one of the most efficient in the area, it is practically certain that the board will make use of it to generate not only Liverpool's needs, but for a considerable proportion of the requirements of the immediate area.

Outdoor Substation For Alaska's Capital



A 1,500-kva. substation in Juneau, Alaska—possibly the northernmost outdoor substation on the continent. It is a General Electric installation and is owned by the Alaska Electric Light & Power Company

BUYING COAL FOR PROFIT—I

Do You Know Your Fuel Markets?

Don't be misled by high efficiencies. Many a "show plant" wastes in coal buying far more than it saves in B.t.u. utilization. How do YOU select fuel? This is the first of four intensely practical articles on coal buying in its relation to energy cost, operating limitations and efficiency

By G. B. GOULD

President
Fuel Engineering Company, New York

THE COST of steam depends more upon the cost and quality of coal than upon any other single factor. In most of the important industrial sections of this country a difference of 50c. a ton in the price of coal will have a greater effect on the cost of steam than a difference of 10 per cent in the efficiency of the plant. This may seem like a wide difference in price to use for comparison, but there exist all the time in the coal market differences in *value* of more than twice this amount.

And yet a few per cent in efficiency is the subject of much sensational publicity in the field of steam engineering, while coal values are scarcely mentioned. One of the new plants widely heralded for its high efficiency, not so long ago, achieved that efficiency as a practical operating matter only with a coal which represented such a severe penalty in the coal market that the resulting fuel cost per thousand pounds of steam was no better than could have been secured from a plant of the vintage of 1915, properly designed to avoid coal-buying limitations.

Recently the writer reviewed a contract under which a new steam plant had been designed for a yearly coal consumption around 20,000 tons and in which all the guarantees of performance were based on coal of a quality that could not have been obtained without paying a penalty of some $20,000 a year above the better coal values obtainable in the same market. High efficiency and capacity were, of course, guaranteed, and no doubt were the center of interest during the negotiations; but the innocent-looking figures that defined the coal characteristics on which these guarantees depended were passed over without a thought as to their economic significance.

Either of these plants would be pointed out as the last word in steam generation, but there are hundreds of older plants in which similar situations exist. They are mentioned simply to show how efficiency and capacity can be so over-emphasized as to completely overshadow a factor of equal or greater economic importance.

Get Acquainted With Coal Markets

Efficiency and capacity have the advantage of being expressed in definite and precise terms. Eighty per cent efficiency means the same thing anywhere, any time. By contrast, coal market values are almost nebulous. No fixed scale of values is possible. The value of any one coal can be expressed only in relation to some other coal, available at the same time. The scale may expand or contract, as a result of changes in individual values, or the whole scale may rise or fall without changing the relation of the individual coals to each other, or one group of coals may rise or fall in relative value faster than the others.

This elastic and constantly moving scale of coal values conceals a vast amount of preventable waste in steam generation—conceals the opportunities even from those who are most directly concerned in discovering them. It presents such difficulties to exact comparison of the economic results among steam plants that some "engineering successes" masquerade as great achievements.

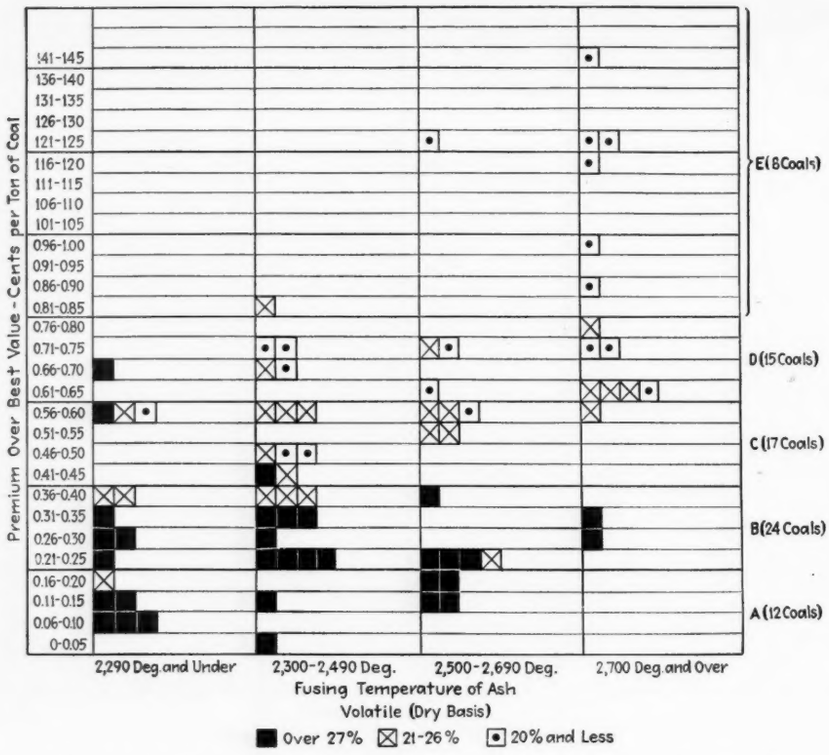
This is not the place to discuss coal-buying limitations from the standpoint of the plant's requirements, but rather the purpose here is to illustrate how coal market values are related to engineering limitations of various kinds which do exist. For it should be remembered that every device so far constructed to burn coal under a boiler imposes *some* coal-buying limitation at *some* rating. Plants differ according to their design and operation in the kind, number and importance of the limitations they impose.

What Determines Coal Prices

Coal is peculiar in that its price is influenced far less by the quality for which it is bought (its energy value) than it is by various physical characteristics, which have a negative or positive influence on the price, according to their effect on the *recovery* of the energy in a particular plant. Take any published tabulation of coal prices and you will find the prices listed according to districts, veins, volatile and size, with no mention of energy value. Other characteristics, such as fusing point and grindability, might be even more appropriately used for price classification.

The fact is that the engineering development of coal-burning equipment has been largely guided toward other objectives, chiefly mechanical means of getting the coal into the furnace and the refuse out. This is natural, for the whole art of converting the energy in coal into steam has been a matter of pioneering, and it can scarcely be said that it has settled down yet. The result is that the widespread existence of accumulated coal-buying limitations of various kinds are definitely reflected in the coal market.

Differences in price according to size are, of course, commonplace, and it is obvious that these differences are greater than any possible variation in energy value. There is often a spread between sizes of fifty cents or more, without including the domestic sizes. At most points of consumption this means a spread of 10 per cent or more of the delivered cost. If the lower-priced class contains an average of 10 per cent of ash, the



Seventy-six coals grouped by ash fusion point and volatile content. (Based on average B.t.u. of each coal from Fuel Engineering Company records and prices quoted in summer of 1930).

higher-priced class would have to be pure coal, with no ash at all, to equalize the difference in price by a greater energy value.

There are more subtle influences on coal prices which are less obvious, but deep-seated. Probably one of the most interesting evidences of this effect of engineering limitations is to be found in the coals of Pennsylvania, Maryland and Northern West Virginia, most of which reach common markets and offer the widest variety of physical characteristics.

A Dollar Analysis of 76 Coals

To illustrate this, a group of definite offers for 76 different identified coals from this field were picked at random from our files. In order to avoid differences in price due to changing level of the market as a whole, these offers were restricted to the Summer of 1930. The average record of quality, derived from samples of numerous actual deliveries of each coal, was tabulated, along with the price quoted and the freight rate to a common destination. For each coal there was then calculated the average number of B.t.u. one cent would buy at the quoted price at the chosen destination, and the coals were arranged in order of their value on this basis.

The individual coal yielding the largest number of heat units for one cent was then taken as the basis for calculating the amount by which each of the other 75 prices would have to be reduced to yield the same value. They were then divided into five groups, the first one containing all coals coming within 20c. of the best value, the second group those between 20 and 40c., and so on, the fifth group including all values which fell 80c. or more short of the best value. The various items in the average analysis were, in turn, averaged for each of these five value groups, with the interesting results shown in the Table I.

It will be noted that, starting with Class A (which includes the coals yielding the most energy value for a dollar) there is a steady progression toward lower volatile, lower sulphur, lower ash, higher B.t.u., higher fusing point and a better grinding index. It is obvious that there must be a very real pressure of demand, which is sufficient to create these price differentials of substantial amount, entirely out of proportion to the differences in the energy value.

Individual Variations Are Buyer's Opportunity

This selective pressure of demand is, of course, a reflection of distinct preferences on the part of buyers who are willing to pay for these other characteristics. And these preferences must be a reflection of either actual or supposed engineering requirements of the plants in which the coal is to be used. In many cases there are very real engineering limitations on the choice of coal. But in many others the limitation is more the result of an inherited prejudice, or of incorrect diagnosis.

It should not be understood from the rather regular progression shown in the items in Table I that the selective demand which causes it is sufficiently discriminating with respect to individual coals to create well-defined classes of coal the characteristics of which can be inferred from their relative cost. These figures are averages. The individual coals within each of these value groups are greatly diversified in character. The average quality of the individual coals comprising Group B, for example, ranges from 22 per cent to 34 per cent in volatile; from 0.9 per cent to 2.8 per cent in sulphur; from 7.4 per cent to 13.9 per cent in ash; from 2,100 deg. to 2,800 deg. in fusing point; and from a comparatively low grinding index, on our scale, of 39-50 to the very high index of 84-90.

Similarly, several individual coals having almost identical qualities will be found to be priced over a wide range. To illustrate this, we have taken the average records of 12 of the 76 coals, and have arranged them in three groups, the four coals in each group being close together in average quality. These are shown in Table II.

Market Price No Measure of Value

Notice what slight differences there are among the coals within each group, and yet a spread in cost (at the arbitrarily assumed point of consumption) amounting to 63c. a ton among the four coals in Group I, of 55 cents a ton in Group II, and 90 cents a ton in Group III. The coals in each group are arranged in the order of their prices, the lowest-priced coal being listed first in each group. It will be seen, therefore, that in some cases the coals offered at the higher prices are actually less desirable than some of the lower-priced coals within the same group.

While the averages by groups in Table I reflect the force of selective demand for certain physical characteristics of coal, they indicate only the *general trend* of buying preferences. When individual values are exam-

ined, it is seen that the market exhibits a surprising lack of relation between values and prices which could only exist in a field in which many buyers are, for one reason or another, not discriminating as to values, even among coals of almost identical characteristics.

In the other important industrial districts which secure their coal either from the southern West Virginia fields or from the Middle West similar differences exist, but with fewer complications. Eastern New England draws from the New River and Pocahontas fields, where there

TABLE I—HOW OTHER FACTORS VARY WITH "ENERGY VALUE"

	B.T.U. for 1c.	Volatile	Sulphur	Ash	B.t.u	FTA *	Grinding Index	Cost per Million B.t.u.	Range in Value Per Ton	Number of Coals
A	71,200	32.9	2.0	9.8	13,850	2,298	53=70	14.0c.	0—20c.	12
B	67,600	28.9	1.9	9.6	13,845	2,400	51=69	14.8c.	20—40c.	24
C	64,400	23.9	1.6	8.3	14,305	2,420	54=74	15.6c.	40—60c.	17
D	62,200	21.2	1.4	8.2	14,305	2,597	61=81	16.1c.	60—80c.	15
E	57,100	19.8	1.2	7.9	14,450	2,670	.....	17.5c.	80c.+	8
										76

*Fusion temperature of ash, deg. F.

(In order to eliminate the effect of size on the value scale, the offers were limited to run of mine in the low-volatile coals, and to slack in the high-volatile coals. Slack coals are infrequently produced in the low-volatile fields, and the inclusion of the screened sizes in the high-volatile coals would only complicate the results by a variable, the effect of which is obvious.)

is a much narrower spread in volatile and a much larger proportion of all the mines produce coal having a fusing point of 2,600 deg. or better.

In Illinois, the coals economically available are all of about the same volatile content, and the normal fusing point range is narrow and usually below 2,400 deg. In the New River and Pocahontas fields domestic sizes are prepared, with the result that slack is available, and in the Middle West numerous sizes are prepared. It is in these fields that size is perhaps the chief difference, other than the inevitable differences in heat value of the product from different mines.

Choosing the Cheapest Within Equipment Limitations

The foregoing illustrates not only the effect of engineering limitations on the coal market, but it also shows how the individual plant must necessarily suffer a definite economic loss if its requirements are too exacting.

This can be seen more clearly when the 76 coal offers, summarized above, are presented graphically, and arranged to show the individual distinctions as to volatile and fusing point. Each square in the accompanying chart represents a coal. They are arranged vertically in the order of their value. The square at the bottom represents the coal which yields the most energy for one dollar. The others are arranged in groups by steps equivalent to five cents a ton premium, after correcting for differences in average B.t.u. They are divided horizontally into four classes according to fusing point, and the type of shading classifies each coal, according to its volatile, into one of three groups.

Taking the fusing point first, it will be noticed that there is none in the highest classification (2,700 deg. or over) within 25c. of the best value, although 8 of the 21 coals that fall within this value limit are at least rated at better than 2,500 deg. and only 1 other in this class is found up to the 50c. line. Only 2 coals out of 41, which can be bought within 50c. of the best value, can be rated at 2,700 deg. or better. The penalty which one must pay for requiring a 2,700-deg. fusing point may be only 30 to 35c., providing there is no objection to having a coal in the higher-volatile range and the plant can efficiently use a slack.

A more serious consequence may follow, however, from the practical difficulties of identifying roughly 5 coals out of every 100 available. At best, coal selection becomes relatively difficult and inflexible, in the absence of comprehensive records on the exact quality of all the coals that might be considered.

The "Try-It" System of Coal Selection

This situation may, and often does, result in a resort to the "try-this-and-try-that" system of coal selection, trying coals somewhat at random to find those with a suitable fusing point. This may work, if you are lucky; but it may also lead to misleading conclusions.

For example, it will be noticed that the 7 coals yielding the least energy value for a dollar are all under 20 per cent in volatile, and 6 of them are classed at 2,700 deg. or better in fusing point. Trying coals at random, one might reach the conclusion that the high-priced coals under 20 per cent in volatile were the only coals which would meet one's fusing-point limitations, simply because every time a coal outside this group was tried the result was disappointing, for there is only about one chance in seven of it being otherwise.

The low-volatile coals are, of course, desirable to certain consumers because they are easier to burn without objectionable smoke. It just so happens that a larger proportion of these coals are also high fusing point, and the combination of qualities makes it possible to market them at a premium.

Where Plant Limitations Are Costly

The important point is that this penalty is a real one, for it is not recoverable in additional energy over what could have been bought at a price equivalent to more than a dollar a ton less if these plant limitations did not exist or could be removed.

There are endless combinations of limitations that might be cited, but after all they would only illustrate in a slightly different form the basic fact that any limitation on coal selection is an economic disadvantage in

TABLE II—PRICE RANGES OF SIMILAR COALS

Identification Number	Volatile	Sulphur	Ash	B.t.u. Dry	F.T.A.
Group I.	Price range $3.88-$4.51 at point of consumption.				
1	33.5%	1.0%	9.9%	13,678	2,450 deg.
2	33.9	1.0	9.6	13,794	2,475 deg.
3	33.9	9.3	9.3	13,637	2,600 deg.
4	29.6	1.4	9.3	13,965	2,200 deg.
Group II.—Price range $4.06-$4.61 (at point of consumption)					
5	25.1	1.0	10.8	14,025	2,600 deg.
6	26.4	1.4	8.5	14,290	2,600 deg.
7	24.8	1.4	8.2	14,296	2,400 deg.
8	25.6	1.8	10.8	13,920	2,450 deg.
Group III.—Price range $4.51-$5.41 (at point of consumption)					
9	22.7	0.9	7.9	14,415	2,700 deg.
10	17.4	0.8	7.6	14,410	2,800 deg.
11	19.6	1.2	8.6	14,308	2,700 deg.
12	20.0	0.8	7.2	14,541	2,800 deg.

steam generation, and the obvious importance of basing coal selection on a careful diagnosis of each plant's actual engineering requirements, and of being sufficiently well informed to recognize the exceptional values within those limits.

The successful conduct of steam generation as a business really requires that both technical theory and practical operating experience be supplemented with a command of the facts in the coal market. For coal market values are realities, just as capable of being measured and appraised by engineering methods as efficiencies, horsepower or kilowatts.

[In the second article of this series, to be published next week, Mr. Gould will show more definitely the relative importance of high efficiencies and intelligent coal selection.—Editor.]

Methods of COOLING TRANSFORMERS

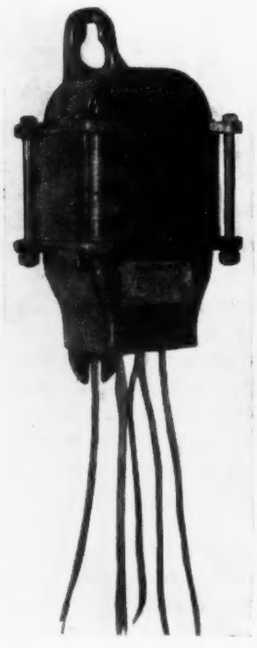
By J. B. GIBBS

Transformer Engineer
Westinghouse Electric & Mfg. Co.

Systems of cooling transformers have changed so radically during the last ten years that modern units have little resemblance to the older types. An outline of the different systems of cooling transformers, and where the various types are used

ENERGY losses occur in all kinds of electrical apparatus. Transformers are no exception to the rule, although their losses are less in proportion than those of most other electrical machines. Transformer losses are of two kinds. The iron loss is the energy required to maintain the alternating flux in the core, and the copper loss is the energy required to overcome the resistance of the windings and to circulate the current through the coils. Both losses appear as heat, and one of the problems of transformer design is to provide means for getting rid of the heat. The method used depends on the size of the transformer and on the condition under which it is to be operated.

Small low-voltage transformers generally operate without oil. In the smaller transformers of this class the coils are wound without ducts, and the transformer may not be inclosed in a metal case. This is possible because a small transformer has a surface that is large in comparison with the volume, and the wattage loss to be dissipated per square inch of surface is therefore small. Also, the heat has a small distance to travel to reach the surface, and the interior of the transformer is therefore not much hotter than the surface. These dry self-cooled designs include most of the small instrument types, as well as transformers of the distribution class for low voltages and for ratings up to about 10 kva. Fig. 1 shows a typical small dry distribution transformer. It is rated 5 kva., 460 to 230 and 115 volts and is suitable for use either indoors or outdoors.



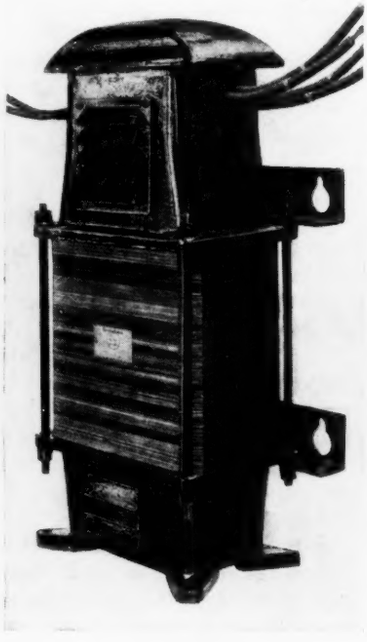


Fig. 1 (Extreme Left) — Small dry-type self-cooled transformer

Fig. 2 (Left) — Ventilated dry-type distribution transformer

Fig. 3 (Right) — Air-blast transformer through which ventilating air is supplied by a fan

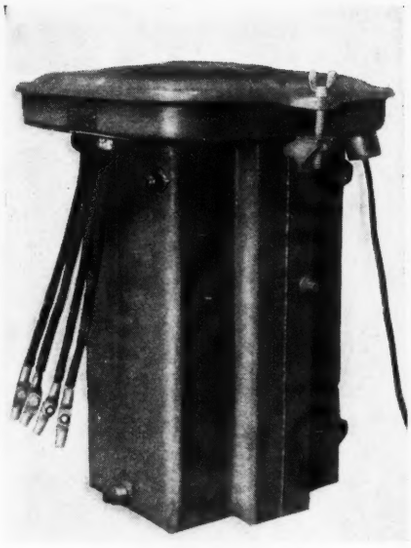


Fig. 4 (Extreme Left)—The tank for a small oil-insulated distribution transformer. The transformer is fastened inside the tank, which is filled with a special grade of oil

Fig. 5 (Left) — Corrugated tank for an oil insulated distribution transformer. Tanks are also used that have more numerous and deeper corrugation than those shown

When dry-type transformers are of more than about 10-kva. capacity, it becomes difficult to cool them if they are totally inclosed, so steps must be taken to increase the amount of surface exposed to the cooling air. This may be done by assembling the transformer with air ducts between the coils. The heat from the coils warms the air in the ducts and it rises while the cooler air from below the transformer enters the ducts. The convection current thus set up carries the heat away from the inside of the coils, and thus supplements the exterior cooling surface of the transformer.

A ventilated dry-type distribution transformer is shown in Fig. 2. The laminations that form the core lie in horizontal planes. Their edges may be seen in the picture. The coils are pancake in shape and their planes are vertical. Spacers placed between them leave vertical air ducts from bottom to top of the transformer. Air enters through louvers in the bottom end cap and is discharged through those in the top end cap and also through slits just under the hat. The purpose of the louvers and of the overhanging hat is to make the transformer drip-proof, should it be exposed to dropping water.

An extension of the principle of the ventilated dry-type is shown in Fig. 3; it is called an air-blast transformer. It is somewhat similar to the small ventilated transformer, but is completely inclosed in a sheet-metal housing. The transformer is installed over a hole in the floor through which air is supplied at a few ounces pressure. The flow of air through the transformer is regulated by a damper, the handle of which may be seen in the picture. The small window at the bottom is to inspect the leads and connections. Air-blast transformers are made in moderate sizes and voltages, but they are used only when the fire hazard prevents the use of oil-insulated transformers.

In general, transformers too large for cooling by natural ventilation are immersed in oil; and even small transformers, especially those for use out of doors or on high-voltage circuits, are often built for oil immersion. Fig. 4 shows the tank for a small oil-insulated distribution transformer. The transformer is fastened inside the tank, which is filled with a special grade of

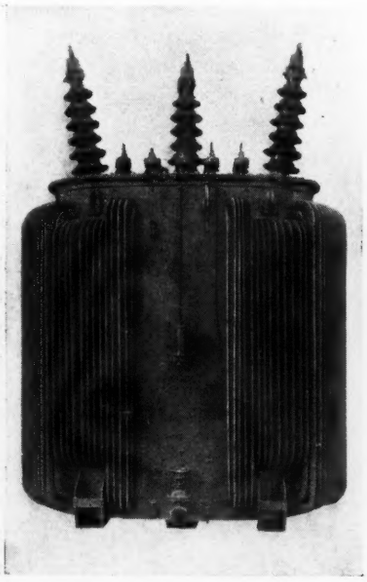


Fig. 6—Tubular-type tank for oil-insulated transformer

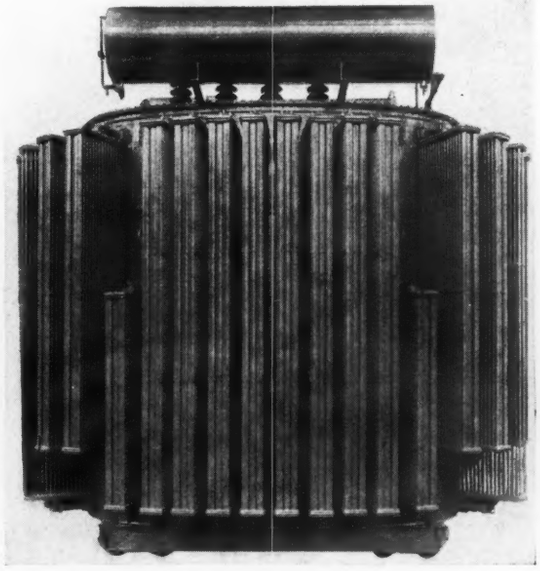


Fig. 7—Large oil-insulated self-cooled transformer tank with external radiator

Fig. 8—Special-type coolers on an oil-insulated transformer tank

oil. The oil not only helps to cool the transformer but also forms a part of the insulation of the windings. As a cooling medium, the oil acts by means of convection currents which circulate the oil up along the heated parts of the transformer, where it absorbs heat, and then down along the cooler surface of the tank, where it gives up heat. The oil thus transfers heat from the transformer to the tank wall, where it is dissipated into the surrounding air.

In small oil-cooled transformers, the tank, which is large enough to contain the transformer, has sufficient surface to dispose of the heat generated in the winding and core. The amount of material in a transformer increases as the cube of its dimensions, whereas the tank surface increases as the square. As transformer sizes are increased, the amount of material and consequently the loss in the transformer increases. A point is soon reached where the tank surface cannot dissipate the heat, and means to increase its ability to do so must be applied.

The first expedient that would occur to a designer would probably be to increase the height of the tank and thus provide more cooling surface, which is often done. This method takes an increased amount of oil, but it retains the simplicity of the plain tank and does not increase the floor space.

In another design the surface of the tank is corrugated. This helps, although a square inch of corrugated wall is not worth as much for cooling as a square inch on a flat-walled tank. The cooling air does not circulate so freely against the corrugations as against a flat surface, and a certain amount of heat radiated by the corrugations is absorbed by adjacent corrugations. This type of tank is much used, however. It enables the exposed surface of the tank to be very largely increased without much of an increase in either the floor space or the oil. The corrugated tank, Fig. 5, is similar to the tank in Fig. 4, with the addition of corrugations. Tanks are also made with corrugations much more numerous and much deeper than those in the figure.

Still another way to increase the exposed surface of tanks is the use of tubes. They are usually bent at both ends and welded at the top and bottom into holes in the tank wall. Fig. 6 shows a large tubular tank. Sometimes tanks are made with a single row of tubes and sometimes with two or three rows, one outside of another, depending on the amount of heat to be dissipated.

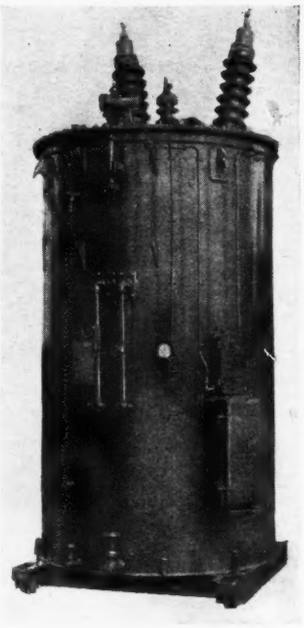


Fig. 11—Water-cooled transformer

Transformers too large to be cooled economically by corrugated or tubular tanks are mounted in boiler-iron tanks provided with radiators, as in Fig. 7. The radiators are connected to the tank at the top and bottom so that the hot oil flows from the top of the tank into the radiator. Here it is cooled and returns to the bottom of the tank ready to rise through the warm ducts of the transformer and repeat the cycle. Many forms of radiators have been used, and the present forms are so effective that self-cooled transformers of any required size can be built. A special form of radiators called coolers is shown on the tank in Fig. 8. Two long narrow steel plates are welded together around their peripheries, leaving a small opening at each end. The plates are also stitched together by welding down the center. The cooler is then blown up by air or hydraulic pressure. This expands the coolers to the form shown and makes passages for the oil through them.

The most recent development in the art of transformer cooling is interesting. It was discovered that if the convection current of air along a heated surface can be

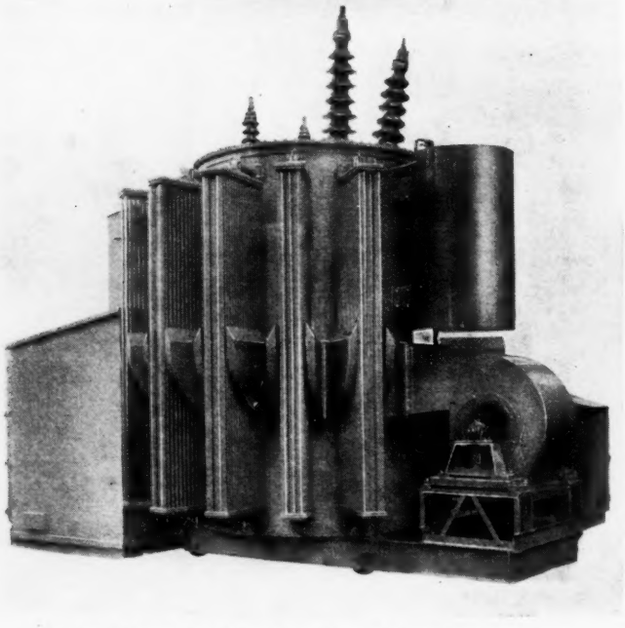


Fig. 9—A large fan is used to blow air over the radiators to increase their cooling capacity

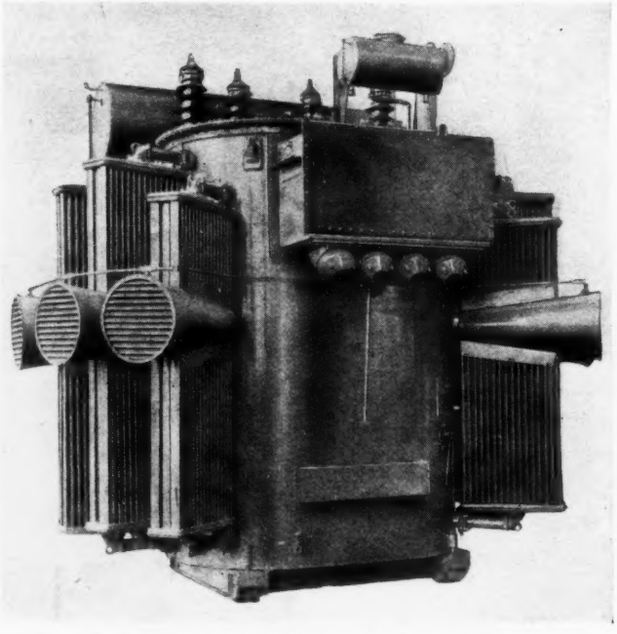


Fig. 10—Small fan installed on each radiator to blow air over its surface

broken up so that the heated air can be driven away from the surface, more cool air comes in contact with the surface, and the effectiveness as a cooling system is increased. The practical embodiment of this idea may take several forms. In one form, Fig. 9, a single large motor-driven fan is used. The discharge from the fan is led into an air duct that surrounds the whole tank. From the air duct, nozzles are led off to blow air against each radiator. This causes cross currents and is effective in breaking up the hot air column.

Fig. 10 shows another method of accomplishing the same result. A small housing of sheet metal covers a small space near the center of the radiator. At the outer end of the housing is an electric fan, similar to the fans generally used in houses and offices. This blows air through the housing against the radiator and causes a cross current as previously explained.

Water cooling of transformers deserves mention, although it is not so much used at present as the methods previously described. A coil of pipe, usually copper, is placed inside the tank just below the surface of the oil. The ends of the pipe extend out through the tank wall and are connected to a water system so that water flows through the pipe while the transformer is operating. The hot oil rising from the transformer comes into contact with the cool pipes and gives up its heat, which is carried

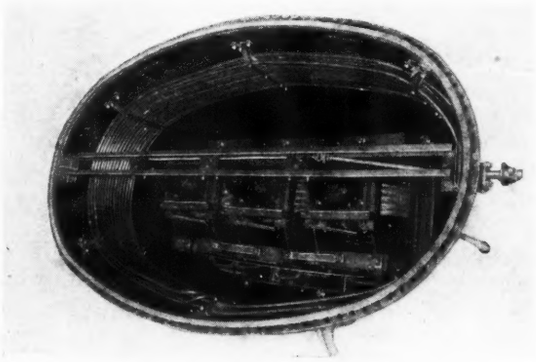


Fig. 12—Looking into the top of a water-cooled transformer. The cooling coils can be seen just inside the tank's wall

away by the water. Water cooling is very effective, and it results in transformers which are smaller and cheaper than those cooled by radiators, but its principal use is where water is plentiful and cheap, and it must be guarded in winter against the possibility of frozen pipes.

The whole problem of transformer cooling is to remove the heat caused by the transformer losses from the coils and core, where it is produced, and to dissipate it into the atmosphere. In self-cooled transformers this dissipation occurs by means of convection currents of air around the transformer itself, or around its tank or radiators. Transformers of the smallest sizes have sufficient surface of their own to dissipate their losses. For larger transformers, tanks must be supplied, and in such cases the transformers are generally immersed in oil, which serves the two-fold purpose of helping to insulate the transformer and transferring heat from the transformer to the tank surface. Various methods are used to get surface enough on the tank to dispose of the heat. Besides the self-cooled transformers, water-cooled types are used, the heat from which is carried away by water flowing through pipes submerged in the oil. The method of dissipating transformer losses thus depends on circumstances.

Mimic Buses on Switchboards Help Visualize System

By EMIL G. BERN
Switchgear Department
General Electric Company

MIMIC BUSES and connections are sometimes placed on the front of control boards to visualize the system of main connections. Although their use is far from general, there are many power plants that demand them, and many switchboards in service will require them when additions to present equipment are made.

On panels of steel or asbestos compound that carry a dull black-lacquer finish it is standard practice to paint the mimic buses and connections in lacquer directly on the panel surface, as in the figure. Often it is desirable to designate different voltages by different colors, and several colors have been selected and standardized.

On panels of natural black slate or marble, and also where such construction is preferred, mimic buses may be made of $\frac{3}{4}$-in. solid metal sections. These can be held to the panels either by countersunk French-head screws in the same manner as the hinges of a piano, or a construction of invisible fasteners may be used. Metal buses and connections are fitted and assembled at the factory for new installations.

Mimic disconnecting switches, as part of a mimic bus system, are occasionally required to indicate the position of selector or sectionalizing switches in the main connections, but should not be used to represent disconnecting switches in series with circuit breakers. It must be recognized that the indication of the mimic switches is dependent upon the setting made by the operator and, therefore, does not constitute a proof of the position of the switches they represent.

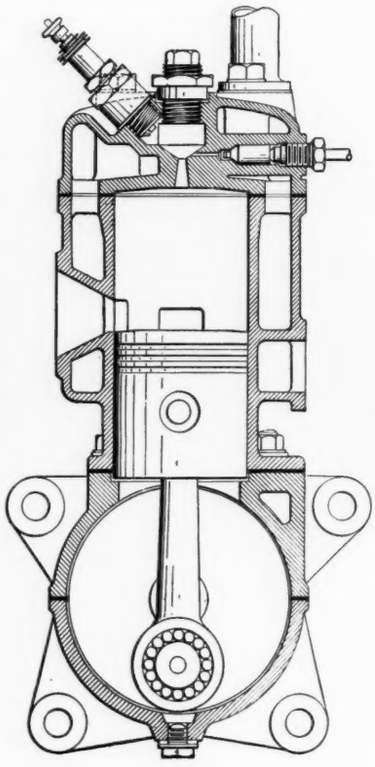
Compact switchboard with mimic buses lacquered on the panel's face

NEW GERMAN SEMI-DIESEL ENGINE

By EDWIN P. A. HEINZE

IN THE DEVELOPMENT of the high-speed oil engine, the semi-diesel principle will not down, as many feel the lower pressures permit a reduction in weight and cost.

An interesting attempt has been made in this direction in Germany by two German engineers, who have invented a new type of motor to work either as diesel or semi-diesel, in which the lower compression and spark-plug ignition of the latter are the sole points of difference between the two systems.



The principle of operation of the motor is highly interesting. The inventors, Eugen Thomas and Robert Stuhr, of Düsseldorf, consider high-pressure pumps and small-bore nozzles objectionable in high-speed diesels, as they are expensive to manufacture, while the nozzles are likely to give trouble through clogging up. The inventors have circumvented these difficulties by the adoption of a low-pressure fuel-feed system and a new form of ante-chamber which is arranged in the cylinder head centrally above the piston crown.

The upper part of this ante-chamber is cylindrical in shape and has a flat top, and the bottom consists of a flat funnel with the apex pointing downward. The apex is connected by a vertical passage of conical section, and a horizontal passage in the wall of the ante-chamber communicates with the delivery side of the low-pressure fuel pump.

When the piston goes up on the compression stroke the fuel pump commences delivery at a very early stage, and has, therefore, to overcome but a slight pressure in the ante-chamber. Owing to the venturi-like form of the vertical passage a high speed is imparted to the air on its progress into the ante-chamber, the speed being higher the greater the piston speed. This high velocity causes a partial vacuum to set up around the top rim of the connecting passage, which draws in the fuel oil being delivered by the pump. A certain quantity of the fuel leaks over the rim and is caught by the air current, to atomize the fuel finely. The sudden increase of pressure caused by the explosion reverses the air current, closes the non-return valve in the fuel-feed opening and drives the burning gas and remaining fuel charge into the engine cylinder, where combustion is completed.

The speed of the converted semi-diesel motor reaches 3,000 r.p.m. Combustion is exceedingly good, for the exhaust gas shows no traces of odor even when starting or when changing gears. A single cylinder experimental engine built by the inventors ran at 4,000 r.p.m., and they hope to obtain that speed in a new engine specially designed from the start to work on the principle evolved by them.

The obvious advantage of this type of motor is its extraordinary simplicity and the cheapness with which it can be produced, since expensive high-pressure pumps and finely calibrated and worked nozzles are dispensed with. The principle of working is just as applicable to four-stroke-cycle motors as to two-stroke-cycle.

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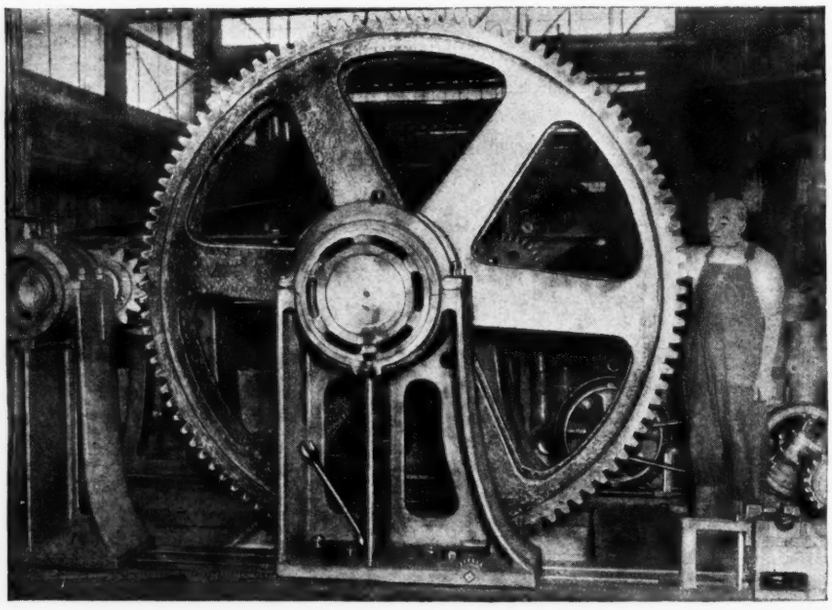
Testing A Big Gear



This cast-steel spur gear is 110 in. in diameter and is designed for heavy-duty service. It is shown being given a running test in the Nuttall Works of the Westinghouse Electric & Manufacturing Company. Ten of these gears were made and a number of others, the smallest of which was nearly 7 ft. in diameter

Appraising Plant Piping

By ROBERT EMERICK
Appraisal Engineer
Day and Zimmerman, Inc.

IN THE general consideration of an appraisal of piping it must be recognized that accurate and dependable results are gained only by treating every plant and each system in the plant as individual units. It is not possible to compare an unappraised plant with the appraisal of a similar plant, and through analogies of horsepower, or kilowatt capacity, or equipment or any other relationship that may exist determine a piping value of any significance. The explanation of this incomparability is in the difference of piping layouts, the difference of material specifications and, in less measure, the difference of erection practice.

What is true of plants as a whole cannot be interpreted differently in considerations of individual systems of piping. There is no law governing the relationship of exhaust steam piping to live steam piping or to boiler-feed piping or to any other system of piping. The value of each system is a matter of individual appraisal.

This law, or rule, or factor, or whatever it is that guarantees the singularity of plants and systems, continues in its functioning down to the individual valves, fittings and pipe that make up a run of piping. Any short-cutting method, such as assuming that in a given length of piping there will be so many valves, a certain number of fittings and a readily computable quantity of flanges, will not, for that reason, in any degree approach the actual state of the piping. There is also in every run of piping, beyond the individualities of layout and material, so much latitude possible in the forms of valves and fittings that the expression "valves and fittings" is itself rendered meaningless. For example, the valves included may be screwed or flanged, or representative of each; they might be gate valves, globe valves, angle valves, check valves, cross valves, inside stem or outside stem and yoke; relief valves, regulating valves, reducing valves, cocks, or any one of innumerable valves designed and installed to perform some special function. The forms of the fittings exceed the valves in numbers and variety, and the cost of individual items may be only a few dollars or in the hundreds. Obviously, then, in any appraisal that bids for accuracy it is not possible to substitute any sort of generality or assumption for the exactitude of physical inspection.

Physical inspection, or inventory, may be pursued directly in the plant or the tabulation of material may be made from drawings; however, the former is probably the more satisfactory, in view of the fact that much pipe work is frequently carried on without any drawing record whatever. In addition, the tying together of lines appearing on several drawings is generally accompanied by errors of both omission and duplication, and in the end there is no absolute assurance that *all* drawings have been received for inspection. In the case of concealed piping, notably underground lines in the distribution systems of central heating plants, the drawings are usually the only available and authoritative instruments of information. This sort of inventory can often be handled

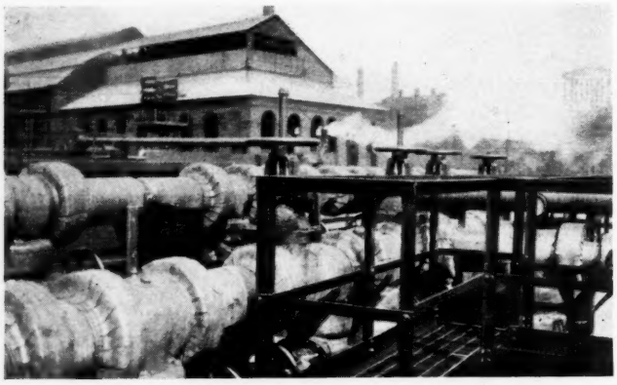
A 36-in. underground steel pipe line. The appraisal engineer must calculate all excavation, backfilling, hauling, paving and shoring

advantageously by two men, one of whom calls out material as he follows the drawing, while the other performs the clerical function of jotting down the named items. The man following the drawing, in this practice, has no need to remove his eyes from a line of piping until it is completed. He can mark off items with colored pencil as he comes to them, and the probability of error in the transcription is reduced to the minimum.

The success of the two-man method with drawings has led to similar practices in field inspections, but is much less satisfactory there and not ordinarily to be recommended. Owing to interferences in the line of vision, and the watchfulness necessary to avoid walking into moving machinery or other sources of personal danger, the man calling items cannot for very long maintain his glance on any particular run of piping. He will be continually losing and finding his place, and that fact is alone sufficient to obviate the primary utility of a second man. Another deterrent to the employment of the two-man system is the difficulty of hearing in an operating plant; the man making notes is frequently unable to distinguish words in the deafening noise, and much time is then unavoidably lost in repetition and asking questions. A third objection to this method in the plant is simply that experience proves that the two men working together will accomplish in a given time little more than would either working alone; and certainly their output as a team does not nearly approach their combined outputs as individuals.

The most satisfactory procedure seems to be that of giving each piping man a particular division at a time,

such as live steam, exhaust steam, boiler-feed water, compressed air and so on, for individual inventory. The work is expedited by the use of a previously printed or mimeographed form on which appear the names of the usually found valves and fittings, together with blank spaces to allow for insertion of the less common items and the sketching of such specialties as adaptor castings on circulating water lines. Such sketches, when exact drawings are not existent or are not available, must portray those details that are a requisite to pricing. Many of these specialties will be found to be cast iron or copper alloy, and in either case weight is a primary element. Recording the quantity of each item, whether special or regular, is done most satisfactory in Roman numerals, as in this manner the value of every mark set down is cumulative, erasures and substitutions are avoided, space is conserved, and the total is readily



Outdoor header with sectionalizing valves for oil heater. Piping appraiser ordinarily estimates the cost of valve-operating platforms

observable at any moment of the inventory without lengthy processes of addition.

Field inspections or inventories will be conducted most expertly, as a rule, by men possessing previous experience in the estimating or pricing of piping. To these men the motive behind the inventory (valuation of the piping) is, subconsciously, always present, and selection of the data necessary to satisfy this motive will be made by them, instinctively, with the maxima of surety and speed.

When a plant has established standards for piping the work is both simplified and expedited. Questions of style and design, of materials and pressures, are answerable at the outset; and the physical make-up of each line, in so far as design and specifications are concerned, is automatically fixed by the nature of the run. Under these conditions the field man needs only, besides size, to inventory a flange as a flange, a gate valve as a gate valve, a tee as a tee. The standards governing these items will then inform him that, if the run is live steam, the flanges are extra heavy, steel, high hub Van Stone; the valves are steel body, Monel stems and mounting for 250 lb. working steam pressure; the tees are extra heavy steel, flanged; or whatever their material and design happens to be. How thorough these standards may be, is observable in the following quotations taken from the piping standards of a utility company.

1—WATER PIPING (excepting underground, drinking water and domestic hot-water lines, which are elsewhere specified separately) for 125 lb. W.S.P.

Pipe 3 in. diameter and under, standard weight genuine wrought iron, screwed, 3½ in. to 22 in. diameter, inclusive, standard weight genuine wrought iron with standard cast iron flanges, screwed on, peaned, faced and drilled.

Fittings, 3 in. and under, standard cast iron, screwed. Over 3 in., standard cast iron flanged. Flanges faced and drilled.

Valves, 1¼ in. and under, standard bronze screwed globes; 2 to 3 in., inclusive, standard cast iron gates, screwed, with outside stem and yoke; 3½ in. and over, standard cast-iron gates, flanged, with bronze stems and mountings. Valves to be "O.S.&Y." with flanges faced and drilled.

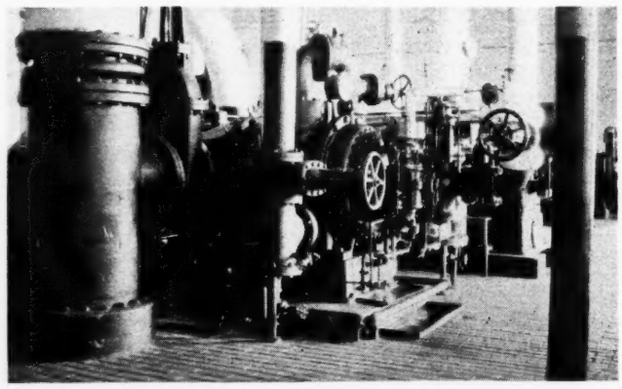
2—STEAM PIPING for 250 lb. gage W.S.P., 750 lb. test pressure, 200 deg. F. superheat, 640 deg. F. temperature. 1½ in. dia. and under, seamless steel screwed tubing; 2 in. to 3 in., inclusive, seamless steel tubing. Van Stone lap type joints, rolled-steel high hub flanges, faced and drilled. 3½ in. dia. and over, extra heavy lap welded steel pipe, Van Stone type lap joints, rolled steel high hub flanges, faced and drilled.

Fittings—1½ in. dia. and under, extra heavy cast or forged steel, screwed. Test pressure 1,000 lb. 2 in. dia. and over, extra heavy cast steel, flanged. Flanges to be faced and drilled with raised faces $\frac{1}{16}$ in. high.

Valves—Test pressures, 800 lb. on bodies and 500 lb. on seats and disks. 1½ in. dia. and under, extra heavy monel, cast steel or forged steel bodies, with monel stems and mountings, screwed. 2 in. dia. and over, extra heavy cast steel bodies. Monel stems and mountings. Flanges faced and drilled, raised faces $\frac{1}{16}$ in. high.

Some plants without particularly specified standards will present, nevertheless, a degree of uniformity that is almost as good; but then there are others in which the pipe work is apparently a composition of odds and ends of things that were handy, and of home-made contraptions that are, not infrequently, of rather astonishing aspect. Such vagabonds of design require detailed treatment; the field man has no escape in them from the task of itemized inspection, and the flange that is covered must be dug into because it may be, with equal likelihood, an ordinary plain-face, cast-iron screwed companion flange, or simply an approximately disk-shaped piece of ¾-in. steel plate with a hole punched in the middle, welded to the pipe, and having any odd number of bolt holes.

A piping problem offering peculiar difficulties to the appraisal engineer is found in the recovery plant of a gas works. Lines connecting to stills, storage tanks, heating tanks, mixing tanks, blow cases, and so on, are allied



A mixed-pressure turbine. For the appraisal engineer it exhibits four distinct piping connections: live steam to the throttle, exhaust steam to the throttle, atmospheric exhaust, and exhaust to condenser

to so great an extent that to discover a run being used for a single purpose is almost impossible. The most workable way out seems to be that of identifying a run by designating its starting and stopping points, and giving to it a number. Through the use of numbers each section is readily identifiable in relation to all connecting and interconnecting sections, and, in addition, this form of inventory makes possible the uninvolved transfer from one classification to another of sections having doubtful or unsatisfactory original groupings.

With the inventory complete, there follows the second step of piping appraisal, the pricing. The most satis-

factory method of applying material prices is that of using net unit figures secured for the purpose from an approved manufacturer, to cover all conventional items, such as pipe, valves and fittings. Specialties, of course, must be considered individually, and their values determined (replacement, historical, or depreciated) in accordance with quotations from their respective manufacturers. Pipe covering must be handled likewise, and the prices secured on this material will in many instances include labor of application as well. The manufacturer will ordinarily quote, unless specifically otherwise directed, on the same basis that governed the original contract.

The labor of pipe erection is a factor in pricing having considerable variability. The rate is subject to change with time and place, and total erection cost when expressed as a percentage of material in accordance with general practice is a variable with its value dependent on the size of the piping. Thus, in small piping, up to, say, one and one-half inches, the cost of erection may exceed 100 per cent of the material value; from two- to four-inch piping, inclusive, 80 per cent; six- and eight-inch piping, 60 per cent, and so on in descending ratio as the size of pipe and its cost increase. Determination of these percentages is fundamental to the pricing and must be based on the date governing the appraisal and on the location of the plant.

Of the fixed charges applying to every valuation, such as engineering fees, insurance, contractors' profits, interest on borrowed money during construction, inspections, tests and similar items, nothing can be said here of any significance. These are peculiar to the development of each plant and must be differentiated accordingly.

▼ ▼ ▼

Testing a Heating System to Locate Leaky Radiator Trap

By WILLIAM ANDERSON

A LEAKY radiator trap generally manifests itself by high-temperature returns or by improper functioning of other radiators. In a large system a leaky trap is difficult to find and a method to test the system for the leaky trap is desirable.

To test each radiator trap at the radiator is not always possible; but testing a number of traps at the foot of a return riser is generally possible; then by any convenient process of elimination the leaking trap can be found.

The equipment required is two metal barrels, such as old oil containers or any available small tanks, and a means of determining the weight of condensation and condensed steam collected in them. Tank No. 1, covered, to receive the condensation and tank No. 2, open, to receive and condense steam. A 2-in. pipe connects them and extends to the bottom of tank No. 2.

The sketch shows the tanks ready for test. If much steam is leaking past the traps, and accuracy is essential, a condenser may be required in the 2-in. pipe.

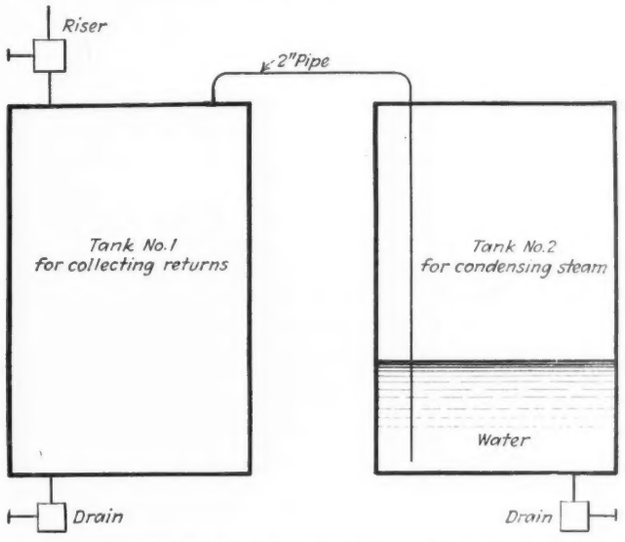
The return riser containing the discharge of traps to be tested is disconnected from the system and connected to tank No. 1 so that the condensation will flow into this tank by gravity, and any steam will pass over to tank No. 2, which is partly filled with water to condense the steam. The test may begin when the riser valve is opened and any unusual noisy injection of steam in tank No. 2 shows much steam is leaking past. These leaking traps should be put in good condition before proceeding further with the test.

Tank No. 1, being subjected to lower pressure than the radiators (if any doubt exists a pressure gage should be attached to the tank) a part of the heat of the liquid will be available for evaporation of the condensation in tank No. 1. The steam formed in this way and the steam passed by leaking traps will pass through the 2-in. connecting pipe to tank No. 2. The additional weight of water in tank No. 2 at the end of the test equals the amount of steam condensed. The excess over that calculated to be from evaporation is the weight of steam that leaked through traps during the test.

If the pressure in the radiators during the test was 5.3 lb., the heat of the liquid would be 196.1 B.t.u. Heat of the liquid at atmospheric pressure is 180 B.t.u. (atmospheric pressure assumed to be in tank No. 1 during test). The heat given up by each pound of water when the pressure is reduced from 5.3 lb. to zero pounds gage is 196.1 — 180 = 16.1 B.t.u.

The latent heat of evaporation at atmospheric pressure is 970.4 B.t.u., then 970.4 ÷ 16.1 = 60, or out of every 60 lb. of water discharged into No. 1 tank 1 lb. will be evaporated into steam. Thus for every 59 lb. of water in tank No. 1 there should be 1 lb. of water in tank No. 2.

Assuming there is removed, after test, 100 lb. of water from tank No. 1, then 100 ÷ 59, or approximately, 1.69 lb. of water should be in tank No. 2. If upon weighing the water in tank No. 2 it is found that 50 lb. has been added, then 50 — 1.69 = 48.31 lb. of steam leaked through the traps during the test. If upon weighing the water in tank No. 2 it is found to be less than calculated, the difference probably is due to the fact that some heat was lost by radiation and, therefore, was not available for evaporating water, and the traps tested are in good condition.



Arrangement of tanks for testing for leaky radiator traps

After each return riser is tested, the traps should be put in good condition and another short test run. The results from this test checked against the results of former test will indicate whether the repair has been successful.

A Measuring Stick For Elevator Service

By HOWARD B. COOK

WHEN SELECTING elevator equipment it is possible to find a number of combinations of car sizes, speeds and types of control that will adequately serve the building. It is usually possible to handle a given number of passengers in a given time with fewer large cars than with small cars. However, the round trip time and the interval between cars will be shorter, and, consequently, the service will be better, with the greater number of small cars. Therefore the selection of elevator equipment for a building should involve the kind of service desired.

No definite standard has been formulated to measure the quality of elevator service. Statements have been made that service cannot be considered good if the interval between cars exceeds a certain arbitrary value, but in most cases the time required to make a round trip has been ignored.

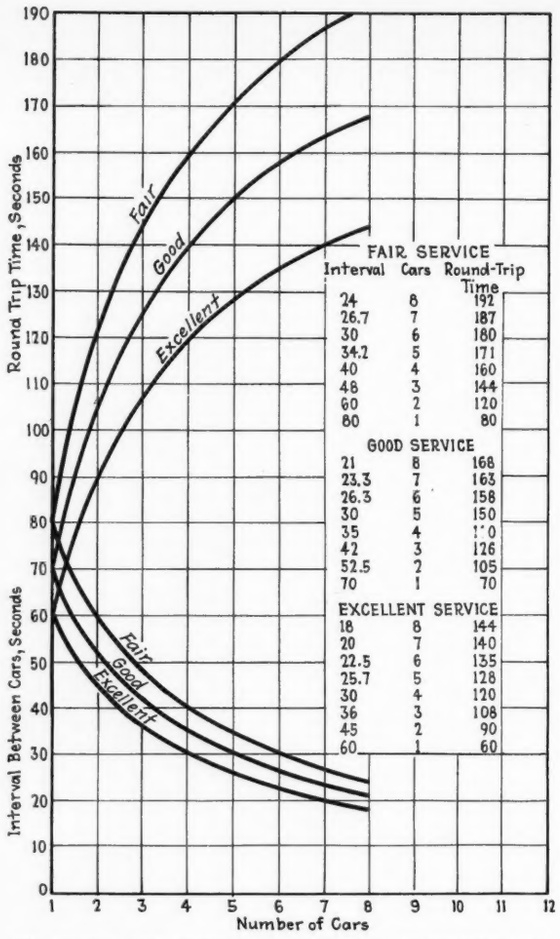
The interval between cars in any bank of elevators is equal to the round trip time divided by the number of cars in the bank. With four cars in a bank an interval of 20 sec. between cars would require a round trip time of 80 sec. With eight cars in a bank an interval of 20 sec. between cars would require a round trip time of 160 seconds.

The average passenger would wait in the hallway 10 sec. after pressing the button before a car stops, in either case. But the average passenger carried in a car, in the bank of four elevators with a round trip time of 80 sec., would have a traveling time only half as long as the average passenger carried by one of the cars in the bank of eight elevators with a round trip time of 160 sec.

It is obvious therefore that the interval of time between cars is not the proper measure of elevator service. This measure is the time required to take the average passenger from the first floor to the average floor, including both the average waiting time and the average traveling time.

The average passenger waiting time is equal to one-half of the interval between cars, and the average traveling time is approximately equal to one-fourth of the round trip time. Consequently, if one-half of the interval between cars is added to one-fourth of the round trip time, the result will be a measure of the service regardless of the number of cars in a bank or the length of travel.

It is possible that this rule should be modified to some extent in those buildings where the cars stand for a considerable period at the terminals. In express service, also, the traveling time of the average passenger will be increased, because passengers are taken to and from a relatively small number of floors near the upper limit of travel. It will be contended that a reduction in waiting time is of greater relative importance than a reduction in traveling time, but this advantage is difficult to evaluate. A reduction in interval might also be considered of greater relative importance to interfloor passenger traffic.



The curves and tables give values for determining the quality of elevator service

The rule suggested is easy to apply and is sufficiently accurate for purposes of comparison. It remains to designate values to represent various degrees of excellence of service.

After considerable investigation of this subject, it has been determined that when one-half of the interval between cars plus one-fourth of the round trip time is equal to 45 sec. the service may be classed as excellent. When the sum of these quantities is 52.5 sec. the service may be called good. When the sum is 60 sec. the service is only fair. The curves and tables give the round trip time and the interval between cars for the three grades of service for various numbers of elevators in a bank.

In many buildings it is customary to shut down one or more of the elevators in a bank during the middle of the morning and afternoon, when the traffic is light. This practice has, in some cases, resulted in criticism of the service. By application of the rule for measuring elevator service it is possible to determine whether a car can be shut down without impairment of the service.

Suppose a building has six elevators in a bank operating at a round trip time of 135 sec., which gives an interval of 22.5 sec. This is excellent service. When the traffic decreases to such an extent as to make possible the maintenance of a round trip time of 128 sec. with five cars the service is still classed as excellent, because the average passenger will be carried to the average floor in 45 sec., that is, $\frac{1}{2}$ of 25.7, the interval between cars, plus, $\frac{1}{4}$ of 128, the round-trip time in seconds, or 12.85+32= 44.85 seconds.

...RIGHT OUT OF THE PLANT...

Obtaining Pulverized-Fuel Samples on Direct Fired Systems

CONSIDERABLE importance should be placed on the proper sampling of pulverized coal for purposes of screen analysis. These screen or sieve tests, used perhaps in conjunction with the pulverizer power consumption, are the only indication of the condition and performance of the mill or pulverizer.

With bins, sampling is comparatively simple, although it is not always easy to obtain a representative sample. A splitter should be used to get the working sample from a comparatively large one. With unit mills it is difficult to get a truly representative sample, and it is doubtful if tests from different plants or even different boilers are directly comparable. We have each watch take a sample as soon as possible after coming on, unless there is some unusual load condition, in which case it can be delayed for not to exceed one hour. In this way we get a sample in the same way at about the same time and load each day, and the results are directly comparable from day to day.

The ducts to our burners are all the same size, with an approximate inside diameter of 10.25 in. Sampling tubes are just ahead of the burners, where there is a straight, almost vertical run of about 10 ft. of pipe. We have divided the area of the pipe into three rings of equal area, as shown in the illustration. Samples are taken across two diameters at right angles and from the nine points indicated by *A, B,* etc. These points are in the center of their respective areas. The sampling pipe is kept at each point (except *C*) for one-half minute and then moved to the next one. It is left at point *C* for one minute. The same procedure is followed across the other diameter.

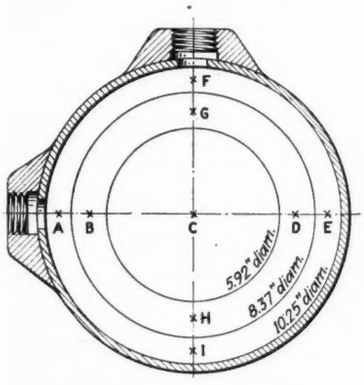


Fig. 1

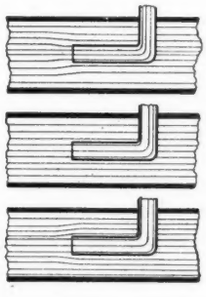


Fig. 3

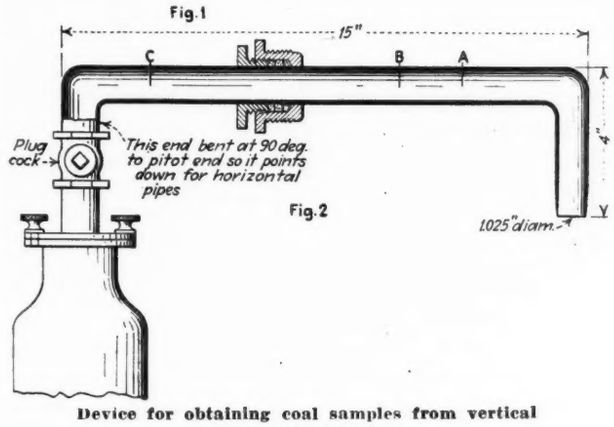


Fig. 2

Device for obtaining coal samples from vertical and horizontal pipes

This gives a two-minute sample from each of the three sample areas, and we use it later as a pitot tube method of measuring the coal flow. If our samples are correct and representative, the amount of coal collected is the amount flowing in two minutes through an area in the duct equal to that of the sampling tube. The diameter of the sampling tube is about 1 sq.in., so that the area is about 0.825 sq.in., or 1/100 of the area of the duct. The total amount of coal flowing in pounds per hour is, then, 3,000 times the coal sample collected. This is compared with the flow-meter record over the same period and should agree fairly well from day to day. It is a combination check on the boiler and mill.

The total sample is weighed in the bag by subtracting the weight of the empty bag from the full bag. It is then shook into a large dry glass jar and run through a splitter, to get the proper-sized sample. It is then put into a ro-tap machine and screened for ten minutes. The sieves are taken out, covers put on and the entire nest placed in large, nearly airtight, cans and kept for the chemist to weigh. Each engineer has his own bag and nest of sieves, for they all shake them out differently. With each man using his own, errors are avoided.

The bags used are regular domestic vacuum sweeper bags. The sampling tube was made in our own shops from a piece of copper tubing bent over and drawn out at the end to give a sharp edge. Ducts have bosses welded on as shown in the sketch and the sampling tube has a bushing with a lightly packed stuffing box which fits this boss. The shank of the tube is marked so that the sampling end can be placed at the proper point *A, B,* etc., as desired.

There is some question as to whether it is possible to get a true sample unless the velocity of the air and dust into the entrance of the tube is the same as in the duct. It is claimed, and is probably true, that if the velocity in the tube is higher than in the duct, air streams will be diverted as shown at the top of Fig. 3, and these streams will carry a higher percentage of fines. If the velocity is too low, as at the bottom, air streams will be diverted away and the sample will not have fines enough. We tried putting the bag in a can from which the flow of air out would be controlled. Then we used small pitot tubes

and a differential draft gage and kept the velocity in the tube the same as in the duct, but could not see that this complicated refinement was of any service to us. As the bag offers little resistance to the escape of air, the velocity in the tube is undoubtedly higher than in the duct, as at the top of Fig. 3. We get a few more of the superfines than we should, but our operation is based on results, and as these results are consistant and used only relatively from day to day they are satisfactory for our use.

When taking samples the pitot tube end must, of course, point directly into the air stream. When sampling vertical pipes both ends should be bent the same way and the weight of the bag hanging free will keep the sampling end in the proper direction. For horizontal pipes the sampling end should be bent at an angle of 90 deg. to the bag end and in such a direction that the sampling end will point upstream when the bag is hanging down.

At first we tried using a valve in the horizontal stem, but this was inconvenient. Now we use a plug valve between the elbow and bag as shown. The man taking the sample can grasp the tube at the bend, manipulate the cock with his thumb and forefinger or push it in or out as desired with one hand without letting go. This allows him to have the other one free to hold his watch. When we start taking the sample, that is, first put the tube in the ducts, the tube is held so that the sampling end points down or backward. Then as the test is started the sampling end can be turned into position by a twist of the wrist and the cock opened at the same time.

For horizontal pipes or pipes where there is considerable eddying and swirling it is perhaps desirable to divide the area of the pipe into more than three sections, say four or five, and take more samples. We started using four sections, but found it unnecessary; in fact we are considering taking samples at only three points, at about *B*, *C* and *D*, as indicated in Fig. 1. P. FRANKS.

Brooklyn, N. Y.

Power Plants Designed to Burn Canadian Lignite

IN THE Jan. 20 number, p. 126, there appeared a photograph and brief reference to the steam-power plant of the Dominion Electric Power Company at Estevan, Sask. The text states that this plant is the first in Canada especially designed to use lignite coal. That is incorrect.

In 1924 Babcock-Wilcox & Goldie-McCulloch, Ltd., sold to the Canada Gas & Electric Corporation, Brandon, Man., a boiler plant specially designed to burn this same coal. The company has no record of the amount of coal burned previous to January, 1926, but in the five years 1926 to 1930, inclusive, the plant burned a total of 169,170 tons of this coal. Since starting up the plant about 200,000 tons of lignite has been burned.

It is evident that the burning of lignite is not a new development in Canada and that a plant using this coal exclusively has been in successful operation for a number of years.

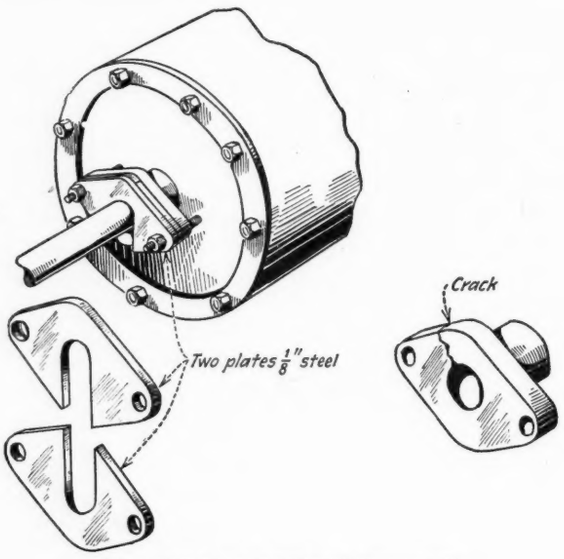
The stokers on which this coal is burned at Brandon are of the Babcock-Wilcox & Goldie-McCulloch chain-grate forced-draft type. A. K. SPOTTON,

Babcock-Wilcox & Goldie-McCulloch, Ltd.

Galt, Ont.

Repairs to Cracked Stuffing Box Gland

WHEN serving as a night engineer at a plant located in a small town, I had a packing gland crack on a feed pump while trying to take it up. To reinforce the gland until a permanent repair could be made, two plates



How gland was reinforced temporarily

of sheet steel were cut as shown in the sketch. As soon as the plates were ready I raised the water level in the boiler as high as possible and shut the pump down long enough to put the two plates in place. This reinforcement permitted the packing to be tightened sufficiently to stop the blowing until a new gland could be obtained.

Concord, N. H. CHAS. H. WILLEY.

As One Reader Values Technical Publications

THE VALUE of a technical periodical depends almost entirely upon the energy applied to reading and studying its contents. If, like a few of my friends, one never removes the mailing wrapper the value of the very best publication is thereby nullified. Or, if the pages are merely glanced at and the periodical then flung aside, its ability to impart knowledge is not materially increased. But if the arrival of the paper is anticipated with pleasure, and each page is carefully scanned for articles, items, or advertisements related to one's work, or otherwise of interest, a vast fund of useful knowledge will gradually be accumulated.

Most of us are rarely able to make journeys throughout the world to keep abreast of progress, to learn of up-to-the-minute developments, or to share in the experiences, very often interesting as well as instructive, of others. If obtained by association one's knowledge is apt to be ill-balanced and unsatisfactory because of the small circle within which so many live and work.

Give me a good technical periodical dealing with subjects pertaining to my interests, a comfortable chair and warmth and light and I will, in an hour or so, visit plants, consider developments and improvements and share in the experiences of others regardless of the separation by distance. And if I visit, for example, a power plant, it is quite probable that the guide will be a person

who possesses authoritative information. I refer to the fact that trained men prepare such articles, men who could not be expected to conduct each visitor about their plants, but who will write splendid technical stories that may be sent to thousands of subscribers. Yes, through the medium of my chosen periodicals I can, while resting comfortably at home, make even more adventuresome journeys than would be possible if my spirit was released by an Indian Yogi.

If specific information pertaining to my work is required it can be generally obtained promptly by writing the publishers of my periodicals. The reply may come from a member of the editorial staff, or in some cases the query is published, and various readers reply thereto. In this connection a friend, who is well-qualified to do so, replied to several queries. During one year payment for these replies was 500 per cent of the cost of his subscription. Aside from this, he finds it very instructive to compare his replies with those of others whose knowledge and experience may be unusually extensive. Were he not a subscriber this friend would have doubtless been ignorant of these queries, and of course, would have missed the opportunity to reply to them.

Another friend receives good payment for technical articles. Spare time was thus used effectively. He lays no claim to being a master of English composition or rules of grammar, simply writing his thoughts and experiences in simple language. Although this friend is fitted by travel, observation, and experience to write on subjects more or less technical, he states that the urge to write was always stimulated by reading good articles brought to him by his periodicals.

Incidentally, the carefully prepared reviews brought to a subscriber cannot be missed if one desires to obtain reliable information pertaining to current technical books.

The weekly and monthly arrivals of my periodicals are as keenly anticipated as the visits of true friends. What jewels may be found beneath their covers. A good editorial is warmly welcomed, and I find many of them.

All considered, it is difficult to understand why a man is willing to be without at least one appropriate technical periodical. A. K. Bay.

Irvington, Calif.

Corrosion of Water Heaters

AS A FURTHER contribution to the discussion that appeared in the March 3 number on corrosion of water heaters, I wish to state that we solved the problem by installing copper heater shells, with copper heating tubes expanded into $\frac{3}{4}$-in. Monel tube sheets. There is no place in these heaters where water is in contact with any other metal than copper and Monel.

We also renewed the distributing system with copper piping and heavy brass fittings. We now get clean water, free of discoloration, at all times. As the cold-water pipes wear out we replace them with copper, because brass piping has not given us the service that copper does. In replacing iron pipes with copper, we make about a third reduction in the diameter. For example, $1\frac{1}{4}$-in. copper replaces 2-in. iron pipe. We spend one hour a year in cleaning a heater with a hose, and about two pounds of dust is all that we find in one when we open it up. Henry C. Dyer, *Chief Engineer,*

Philadelphia, Pa. Racquet Club.

Protecting the Coil Ends in Induction Motors

AFTER rewinding a 400-hp. 2,300-volt induction motor it was discovered that the winder had injured the insulation on the ends of a number of the coils when driving the wedges into the slots. To prevent this occurring when rewinding other machines, after the coils were all in place and before driving in the wedges, strips of canvas were cut and placed over the coil ends. These strips were wide enough to extend from the core out over the end of the coils. The canvas was painted lightly on one side and this side was placed next to the coil ends. With the canvas over the coils, if the winder happened to make a slip with the hammer and hit the coil ends, the canvas protected the insulation from injury.

When the job was completed the canvas was removed and the coils had a neat appearance. I have applied this practice to both large and medium-sized machines. Ralph E. MacKay.

Butte, Mont.

Exhaust Connection For Tugboat Engine

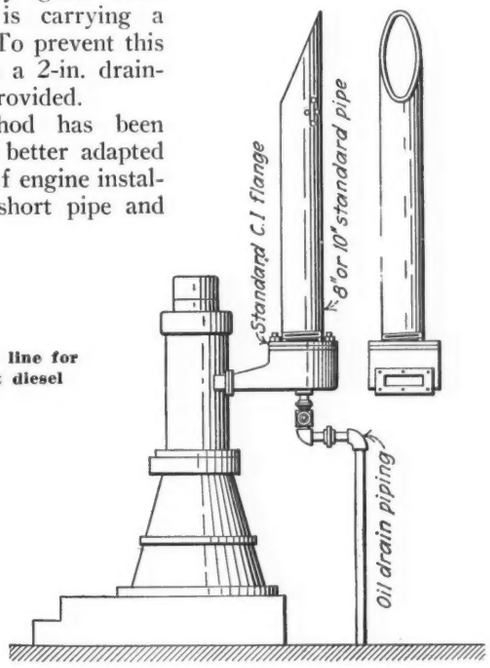
IT IS sometimes desirable to eliminate the drum-type exhaust muffler for oil engines installed in dredges and towboats. A means of meeting this situation is shown in the illustration.

A casting leads the exhaust into the vertical pipe. The friction is less than with the usual muffler, for the attachment is wider and the elbow is shaped to give minimum of resistance.

Considerable oil and fuel goes over into the exhaust pipe and may ignite when the engine is carrying a heavy load. To prevent this accumulation a 2-in. drainage pipe is provided.

This method has been found much better adapted to this kind of engine installation than short pipe and elbows. The shape of the outlet contributes considerably to silencing the exhaust. Orville Adams.

Dallas, Texas.



Exhaust line for tugboat diesel

From Among Readers' Problems

Conducted by
L. H. MORRISON

CORROSION OF OXYGEN TANK—*An oxygen gas holder of the water seal type with a movable bell section of 50,000 cu.ft. capacity is subject to a uniform corrosion of the interior side of the bell. The corrosion is concentrated to the most eastern side of the bell section, where No. 10 gage sheets are corroded to such an extent that they have to be replaced in a short period of time. The top and the western side of the bell are not affected by corrosion.*

The gas inlet is on the western side of the holder and the outlet is on the eastern side of the holder.

Suggestions as to the cause of the corrosion of the eastern section of the holder, and the remedy, would be greatly appreciated. R.F.W.

Probably the oxygen enters the holder in a fairly dry state, that is, free from moisture. In flowing to the outlet it may pick up moisture from the water seal, and, as the corrosiveness of oxygen increases with moisture content, the eastern part of the tank is attacked.

Paint the material with some paint not affected by oxygen. There are metallic-lead paints that are quite satisfactory for this purpose.

INCREASED HEATER SURFACE—*We have installed a new closed heater giving a water temperature of 210 to 211 deg. F. If it would increase the temperature, I should like to let the water from an overhead tank flow through the old closed heater to the pump, as there is a 20-lb. head and the pump would force the water through the new heater to the boilers. This old heater gave us water at 155 to 160 deg. F. Our well water is 80 deg. We have plenty of exhaust steam. Would there be any rise in temperature by connecting these heaters in series?* P.P.J.

If you are operating your engine or turbine at a few pounds back pressure, you cannot hope to heat the feed water much above 212 deg. F. This is the temperature of steam at zero gage, and at 3 lb. back pressure the steam temperature would be 221 deg. F. You should have 5 to 10 deg. difference between the water and steam temperature to give ample heat transfer with a reasonable heater surface. Adding a second heater would, of course, increase the heating surface and so decrease the necessary temperature difference, but the addition seems hardly justified. An increase of 5 deg. water temperature would save about one pound of coal for every 2,000 lb. of water fed to the boiler. So long as you have much excess exhaust it might pay to install the second heater to permit a reduction in the back pressure while maintaining a 212-deg. water temperature.

TEMPERATURE AT WHICH SOLDER MELTS—*At what temperature does tin-lead solder melt and how is the melting temperature affected by the proportion of tin and lead used?* C.R.E.

Tin-lead alloys begin to melt at 361 deg. F. A composition of 62 per cent tin and 38 per cent lead has a definite melting point of 361 deg. F. Tin alone melts at 449 deg. F. and lead at 619 deg. F. But between the range of 361 deg. and 619 deg. F. a tin-lead alloy is soft, and is likely to fail as a filling or cement about a conductor within a lug or terminal.

At 0 per cent lead and 100 per cent tin the melting point is 449 deg. From this value it decreases to 361 deg. to cause complete melting as the lead content is increased to 38 per cent. From this minimum melting point of 361 deg. the temperature required to bring about complete fluidity increases to 619 deg. F. as the percentage of lead is increased to 100.

OPERATING TWO-STAGE COMPRESSOR SINGLE-STAGE—*We are operating a two-stage air compressor of 3,000-c.f.m. capacity, and have a leak in the intercooler. Would it be possible to operate this compressor by cutting out the intercooler to make repairs and by-passing the air from the low- to the high-pressure cylinder? What difference would it make to the compressor, and what precaution should be taken?* C.H.W.

There might be some danger in operating the compressor without the intercooler, for the final temperature in the high-pressure cylinder might reach the ignition point of the lubricating oil.

You do not state the discharge pressure, so to illustrate the problem I shall assume 90-lb. gage, and that the inter-stage pressure ratio is the square root of the total pressure ratio in terms of absolute pressure, or

$$\sqrt{\frac{105}{15}} \text{ or } 2.646.$$

This makes the intermediate pressure $15 \times 2.646 = 39.7$ pounds absolute.

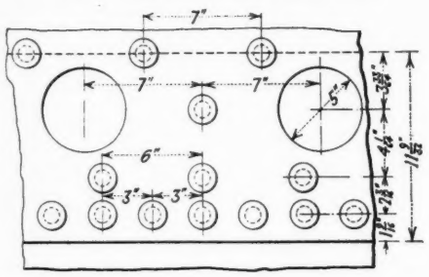
With a low-pressure intake temperature of 60 deg. F. (520 deg. abs.) the temperature of the air entering the intercooler will be found by the relation

$$T_1 = T\left(\frac{P_1}{P}\right)^{0.29}$$

Where T_1 = intermediate temperature; T = intake temperature = 520 deg. F. abs.; P_1 = intermediate pressure = 39.7 lb. abs.; P = intake pressure = 15 lb. abs.

Two Questions for Our Readers

1. WHAT working pressure can be carried on the drum whose seam is shown in the illustration? The 5-in. openings are for the tubes. The specifications are as follows: Material, firebox 55,000-lb. steel; plate thickness $1\frac{1}{16}$-in.; outer strap -in.; inner strap $\frac{3}{4}$-in.; rivet holes $1\frac{3}{32}$-in. W.G.D.



2. WHAT IS THE RELATION of the air ejector capacity to the capacity of the condenser? For example, should the ejector of a 10,000 kw. condenser be twice as large as one on a 5,000 kw. unit? A.G.C.

Suitable answers to these questions will be paid for[1] and published in the May 12 number

[1]As an alternative to cash payment for answers published, readers may select any one of the following books:

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fritz' *Refrigeration*; Rietschel - Brabee's *Heating and Ventilation*; Annett's *Electric Elevators*.

Substituting these values,

$T_1 = 520\left(\frac{39.7}{15}\right)^{0.29}$, or

T_1 = 686 deg. F. abs., or 146 deg. F. This assumes adiabatic compression, that is, compression without loss of heat to the cylinder jacket.

It is not unreasonable to expect the intercooler to bring the air temperature back to within 20 deg. F. of the suction temperature, or 80 deg. F., which is 600 deg. F. on the absolute scale.

The high-pressure discharge temperature may be found by the same process as used in calculating the intermediate temperature, working out as T_2 = 792 deg. F. abs., or 332 deg. on the Fahrenheit scale. Consider now the situation with the intercooler cut out. We have

$T_3 = T\left(\frac{105}{15}\right)^{0.29}$

or the high pressure discharge temperature in 1.76 × 520 = 915 deg. abs., or 455 deg. F., which might prove dangerous.

Probably in an emergency the bypassing of the intercooler is justified, providing close watch is kept on the discharge temperature and a minimum amount of lubricating oil is used.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WHEN junior size underfeed mechanical stokers are installed under the grates of down-draft boilers the comparatively cold, water-filled grates are immersed in the hot zone of the fire, and complete combustion may not be secured.

The question arises, how far below water grates should the retort bowl of an underfeed stoker be placed for most efficient and smokeless combustion of high-volatile fuels? In other words, what value, if any, has the space above the water grates for completing the combustion of volatile gases?

IN THIS section the practice is to remove the upper grates or water tubes, because of the detrimental effect upon combustion. We have found that in the installation of underfeed stokers the operation is sufficiently smokeless to enable the operator to dispense with any accessories other than the equipment usually installed on a standard boiler.

Bridge walls should not exceed the height of the retort by more than 16 in., and the space between the bridge wall and the shell should never be less than 9 in. It has been the practice to construct a bridge wall with a flat top. This has been very effective in the preservation of boiler doors. It should be understood that we consider the down-draft grates worthless so far as the efficiency of the stoker is concerned, so we convert the boiler to a single-grate type. There has been no noticeable loss in the boiler efficiency and much favorable comment on the improved service of the automatic control provided with the stoker.

I have not made any attempt at systematic CO_2 exploration, but in one case curiosity prompted a reading where the water tubes had been removed. It was very satisfactory, 11.6 per cent CO_2 with a stack temperature of 595 deg.

I recommend the removal of the water grates and their baffle, and the construction of a low bridge wall to permit economical service and preservation of doors.

PAT ROONEY,
Knoxville, Tenn. S. T. Weaver Co.

IN THE first place the use of an underfeed stoker under a down-draft boiler is at best a makeshift. The down-draft boiler has many special features of design intended primarily to provide for the smokeless burning of volatile fuels by the hand-firing method. All of these desirable features are sacrificed by the introduction of an underfeed stoker.

In the second place, the mechanical stoker will not perform to its best advantage in a firebox shaped like that of a down-draft boiler, this slight inefficiency being not so much a matter of varying CO_2 content throughout the combustion space, as it is of eddy currents and dead spots in the firebox.

The water grates are ordinarily an essential part of the circulation system of the boiler and should not be eliminated. It is the space above the water grates that is troublesome from a draft standpoint, and since this space is not designed for heat transfer it would seem better to blank it off with a refractory arch laid on the water grates. And with the retort bowl located at approximately the level of the original fire grates the system should operate with the greatest possible efficiency.

WILLIAM L. FORGIE.
Washington, Pa.

THE UNDERFEED stoker and the down-draft grate burn fuel on the same principle, although mechanically they are very different. Both give better combustion than ordinary hand-firing of green coal on a coke fire. The primary air is admitted through the green side of the fuel bed, thus distilling the gases into the hotter portion of the fire. Where one is to be used the other is obviously not required. The advantages of the stoker over the down-draft are too numerous to mention here.

It may be impracticable to place the underfeed stoker far enough below the water grates to obtain good results without expensive alterations to the setting. With the water grates in place, the area above is of no value to proper combustion, and the grates themselves are a detriment. If the grates are not an integral part of the boiler to the extent that they can be removed without impeding the circulation, it is better that they be removed and this otherwise valueless space utilized as combustion space.

If removing the grates is not possible, the next most satisfactory way would be to cover them with tile or plastic refractory. The latter would no doubt be the most economical. This would provide an incandescent arch to further promote combustion. A form could be built under the water grates and the plastic pounded in place from above to form a monolithic arch when the refractory has thoroughly dried and vitrified. Radiation from this arch would impart a great amount of heat to the water grates and help the circulation.

Cubical space in fireboxes is often limited to the minimum. Unless the distance between water grates and stoker can be increased about 33 per cent over the distance generally provided between the down-draft grates and the stationary grates, it would be to greater advantage to remove the water grates and utilize the additional space for proper combustion of the volatile gases.

G. E. BATHMAN.
Chattanooga, Tenn.

FROM MY experience, it would be impossible to install an underfeed stoker in a firebox boiler with down-draft grates.

To install an underfeed stoker in this type of boiler there should be two clean-out doors installed in the back-door sheet of the boiler, one on each side of the back head. The top of these doors would come on a line with the water grate, and it would be necessary to remove that part of grate from both sides.

I see no objection to leaving the center water grates in position, allowing a space of about 15 in. measured from the surface of the water grate to the stoker retort bowl.

T. F. DOWNEY,
T. F. Downey Boiler Works.
Kansas City, Mo.

THE ENGINEER'S B

A.S.M.E. 1930 Boiler Code

A.S.M.E. Boiler Construction Code, 1930. *Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City; 1930. Cloth, 5x8 in.; 274 pages; diagrams, charts, and tables. Price, $2.50.*

HERE in one compact volume are the latest rules for the construction of power boilers, new specifications covering materials used in boiler construction, and up-to-date rules governing inspection. The specifications in this code have been formulated by the A.S.M.E. Boiler Code Committee, comprising a main body of 23 prominent specialists.

The new edition of the code is a complete revision of that for 1927. Many important rules have been incorporated to provide for the rapid progress in the boiler industry. Provisions have been made for the reinforcement of openings in boiler shells for all purposes, and improved requirements for the construction of dished heads have been added. There have also been introduced into this edition means of measuring the weakening effect of a group of holes cut in a cylindrical shell along the longitudinal line, as well as a comprehensive set of rules for nozzle openings for every type and form. Important changes have been made in the safety requirements for boilers, and new rules have been included to cover welded construction.

Covering as it does the entire subject of boiler construction, the book is indispensible to the designer, manufacturer and purchaser of boilers.

Leather Belting Data

Treatise on Leather Belting. *By George B. Haven and George W. Swett, both professors of machine design at Massachusetts Institute of Technology. Published by the American Leather Belting Association, 41 Park Row, New York City; 1931. Cloth, 5x8 in.; 249 pages; diagrams, charts, and tables. Price, $1.50.*

COVERING the subject from the first step in leather manufacture to the many applications in mechanical power transmission, this book presents the first comprehensive compilation of data on leather belting. It contains ten chapters, conveniently tab-indexed, the first three of which deal with the physical properties of belting leather, the preparation of leather, and the methods used in the manufacture of the belting itself. The next three chapters deal with the use of belting, presenting information on the choice of the proper belt for the particular application, the installation and care of leather belting, and the use of leather belts on motor installations. Dealing comprehensively with the subjects of belt-drive engineering and research, specifications and inspection, the last four chapters contain a wealth of mathematical tables and original nomographic charts.

Standard Hydraulics Text Revised

Reviewed by

LEWIS F. MOODY

Professor of Hydraulic Engineering, Princeton University; Consulting Engineer, Cramp-Morris Industrials, Inc.

Hydraulics. *Fifth Edition. By Frederick Charles Lea, professor of mechanical engineering, University of Sheffield, England. Published by Longmans, Green & Company, 55 Fifth Ave., New York City; 1930. Leatherette, 5½x8½ in.; 775 pages, diagrams and charts. Price, $7.50.*

SINCE its first edition, prepared in 1907, Lea's "Hydraulics" has been a standard text in its field. As explained in the preface to the new edition, the author has taken the opportunity to incorporate much new material representing advances made during the 22 years since the first publication. The author's statement can be readily appreciated that the task of revision has not been a light one; but that the amount of added material is considerable is suggested by the increase in bulk from 520 original pages of text to 760 pages in this edition.

The author himself has been the originator of a number of the new developments included, representing researches and tests carried out or sponsored by himself. Some of the most important of these additions are in the field of pipe and channel resistance, in which he has covered at some length the work of recent experimenters such as Stanton and Pannell and others, supplemented by his own researches.

The first two chapters, on hydrostatics, have been little changed, with minor additions such as the description of a sensitive gage for low pressures. In Chapter III, on fluids in motion, there are found interesting additions comprising new material on stream-line motion and treatment of the venturi flume in open channels and accelerated flow. The most important additions to Chapters IV to VI appear to be those on orifices and weirs and on pipe and open-channel flow. Some of the interesting and useful additions noted in the chapters are those on the theory of similarity for orifices and weirs, which are excellent; the new tables and curves of coefficients from recent researches, the inclusion of the "standing wave" or hydraulic jump, siphon spillway and circular weir. In view of the full treatment given to the subject of weirs, the omission of the work of Rehbock is unfortunate.

It is perhaps too much to ask that foreign developments be fully covered, but the advances made in Germany and America in recent years seem to receive inadequate attention. These advances have, however, been so rapid that it is not surprising that any writer should be unable to cover all the important contributions.

In Chapter V there is an excellent new section on the Reynolds number, with a full discussion of the Stanton and Pannell experiments and those of the author. There is additional material on bends and elbows, water-hammer, and types of valves (note the omission of the Johnson type of valve). In the discussion of the curve of velocity distribution across a pipe, I should have suggested the suppression of the old elliptical curve theory and substitution of the new German exponential basis.

The chapter on open-channel flow, which was a valuable one in the first edition, has been amplified. The material on the application of the exponential formula for channel resistance is believed to be most useful, and a welcome means of escape from the nonrational complexity of the Kutter formula. In addition to new matter on variable sections and backwater function, rise and fall in reservoirs and wave motion in channels, the chapter includes at the end an interesting "Short account of the historical development of the pipe and channel formulas," with useful illustrative problems worked out.

In Chapter VII, on flow measurement, have been included the titration method and the Allen salt-velocity method. I do not find in the titration material any reference to the American work of B. F. Groat; but the most serious omission is the failure to cover the Gibson pressure-time method, which not only deserves attention on account of its originality but because the Gibson method shares with the Allen method the position of being one of the most approved ways of measuring large flows.

The material on hydraulic turbines does not appear to be as notable as the other portions of the book. Much obsolete material on gravity wheels and early turbine forms could well have been omitted, together with the "cone turbine" which is included with "modern forms." A sectional view is given of a notable American installation (one of the Conowingo units) without identification. Nothing is found on the vital subject

R'S BOOKSHELF

of cavitation or treatment of scale effect on turbine efficiencies. On account of the lack of water-power resources in England, modern English texts are naturally not particularly strong in the treatment of turbines.

While the length of the book is likely to discourage its use as a textbook for undergraduate courses in American engineering schools—since few of our schools are able to include in their crowded curricula an adequate time for hydraulics—it is considered a most valuable work for use as a reference text, and for the use of the graduate student, experimenter and practicing engineer.

Practical Kinks

TWENTIETH CENTURY BOOK OF RECIPES, FORMULAS AND PROCESSES. *Edited by Gardner D. Hiscox. Published by the Norman W. Henley Publishing Company, 2 West 45th St., New York City; 1930. Cloth, 6x9; 786 pages. Price, $4.*

THIS REVISED EDITION of a well known book will find a ready sale to those who from time to time have need of formulas, such as rust prevention, painting, soldering and the like. For those interested in power-plant repair, there are many recipes or methods outlined for hardening steels, on lubricating oils, insulation, and on a hundred other articles.

Evolution of Science

A HISTORY OF SCIENCE: *By William Cecil Dampier-Whetham. Published by The MacMillan Company, 60 Fifth Ave., New York City; 1931. Cloth, 6x9 in.; 492 pages. Price, $4.*

MANKIND owes its culture to its insistent urge toward the discovery of the mysterious and unknown, and for the mass of us, the unknowable.

Of late there has developed along with the second-hand automobile market, a market for second-hand science. The man of today does not desire his science at first hand; rather he wishes to be told what scientists have done and are doing. In spite of the fact that our average citizen cannot understand the quantum theory, nor the electron, nor the cosmic ray, he is loud in his insistance that he be told. Naturally the tellers appear, for no demand fails to find a supply.

But most of the many popular science books now flooding the market are decidedly inferior, because the authors it appears, accept the statement that the average man has the I.Q. of a child of twelve. Either the story must be childish and fairy-wise to meet the capacity of the reader, or he must be confronted with a mass of dull scientific pages, in the reading of which he can understand the meaning of the individual words but is utterly unable to appreciate the thought embraced in the word grouping. But why worry; we are becoming educated.

The volume by Damphier-Whetham, on the other hand, is the ideal of what a book on science for the layman should be. He has connected each scientific advance with its discoverer and while the book cannot be termed light summer reading, it is excellently readable, and the average man with a college, or equivalent cultural, background, will find it intensely interesting.

Engineering Economics

ECONOMIC CONTROL OF ENGINEERING AND MANUFACTURING. *By Frank L. Eidmann, professor of mechanical engineering, Columbia University. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1931. Cloth, 6x9 in.; 402 pages, illustrated. Price $4.*

DEALING with the problems of engineering and manufacturing whose solution depends upon economic analysis, this book discusses such topics as the selection of equipment for minimum-cost production, choosing between hand labor and machinery, the choice of materials in manufacturing, whether to generate or purchase power, industrial research, standardization and simplification, and marketing policies. All phases of manufacturing and related engineering from the choice of plant location to placing the finished product in the consumer's hands are treated in the book from the economic angle, with many illustrative examples drawn from actual practice.

In the chapter on the economics of the power plant, typical analyses of the costs of generating and purchasing power in industrial plants are presented to show how a decision should be reached in the individual case. Savings produced by power-plant accessories are analyzed and discussed, together with the commercial and furnace efficiencies of the plant.

The book is altogether in keeping with the economic viewpoint of modern engineering, and as such should prove a valuable aid to engineers engaged in the manufacturing industries.

Modern Diesel Practice

MODERN DIESEL ENGINE PRACTICE. *By Orville Adams, consulting diesel engineer. Published by the Norman W. Henley Publishing Company, 2 West 45th St., New York City; 1931. Cloth, 6x9 in.; 628 pages, 369 illustrations. Price, $6.*

Reviewed by

M. J. REED

Research Engineer,
Diesel Engine Manufacturers Association

THE REVIEWER cannot help but wish that someone had devoted real thought to the arrangement of Mr. Adams' book. Engineers are perhaps poor at that sort of thing—publishers, however, are supposed to be expert at it. So pell-mell is the arrangement of "Modern Diesel Engine Practice" that one finds various topics discussed not alone in two places but often in three and four different locations, and not always with the same fundamental treatment. In one way, this is not regrettable, for it appears that there are truths which cannot be repeated too often. However, the arrangement cannot but confuse those who will use this otherwise worth-while book for reference purposes.

The author presents a wealth of information on the economics, operation and repair of diesel engines and the layout of diesel plants. Not only does he supply us generously with facts and figures out of his own wide experience, but he does not hesitate to draw extensively upon other authorities. It is especially gratifying to the Diesel Engine Manufacturers' Association that its modest booklet of "Standards" is so wholeheartedly accepted as the gospel on so many points.

He lays a particular emphasis on portable and semi-portable diesel engines—engines for locomotives, shovels, trucks and buses, etc. In view of the fact that this type of diesel is on the threshold of a future of widespread use, the emphasis is timely.

Probably few in America can speak with the authority of Mr. Adams on the subject of major field repairs of diesels. It is not surprising, therefore, that his chapter on "Diesel Repair and Maintenance" should be one of the most interesting in the book.

Perhaps the 1929 report of the American Society of Mechanical Engineers Sub-Committee on Oil Engine Power Cost was not available to Mr. Adams before the completion of his manuscript. Had it been, it is almost certain he would not have made the statement which he does about the truthfulness of diesel cost reports by "learned societies."

Authors cannot be letter-perfect on all subjects related to their main themes, and Mr. Adams is, of course, no exception. Consequently, we find this book slightly out of date and somewhat superficial on several topics, especially the question of Diesel fuel oil. Sulphur content, bottom sediment, and water—these are questions that no longer puzzle so-

phisticated buyers. The critical properties of fuel oil as they are understood today are carbon content, viscosity, and unsaturated hydrocarbon compounds. The whole subject of the economics of diesel fuel oil as affected by modern refining methods and modern demand for distillate oil is a very absorbing one and deserves fuller and more understanding treatment.

Boiler Embrittlement

EMBRITTLEMENT IN BOILERS. *By Fredcrick G. Straub. Bulletin No. 216, Engineering Experiment Station, published by the University of Illinois, Urbana, Ill.; 1930. Paper, 6x9 in.; 128 pages, illustrated. Price, 65 cents.*

THIS important bulletin is the report of an investigation conducted by the Engineering Experiment Station of the University of Illinois, in co-operation with the Utilities Research Commission. It is, in part, a reprint of Bulletin No. 155, "The Cause and Prevention of Embrittlement of Boiler Plate," by Samuel W. Parr and Frederick G. Straub (1926), and Bulletin No. 177, "Embrittlement of Boiler Plate," by Parr and Straub (1928). To these are added the results of subsequent investigations to date. The bulletin gives a résumé of present knowledge of embrittlement that should be extremely interesting to manufacturers, operators, and consulting engineers concerned with this problem.

Following the introduction, and a review of field experience with embrittlement, 41 pages are devoted to laboratory experiments, including such matter as micro-examination, reproduction of embrittlement cracking, accelerated testing apparatus, laboratory tests on sodium sulphate and sodium carbonate as inhibitants, solubility studies, other inhibiting agents, and concentration of solutions in capillary spaces. After a discussion of results and a summary of conclusions, the bulletin ends with four appendices, including a bibliography, a study of embrittlement at the University of Illinois power plant, data from embrittled waters and a determination of phosphate in boiler water.

Science of Safety

INDUSTRIAL ACCIDENT PREVENTION. *By H. W. Heinrich, assistant superintendent of the engineering and inspection division, Travelers Insurance Company. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1931. Cloth, 5½x8½ in.; 366 pages, illustrated. Price, $4.*

AS INDICATED by the subtitle of this book, the author has taken the "scientific approach" to the subject of accident prevention in industry. He believes that there is a science of accident prevention founded on relatively simple principles and that the ineffectiveness of most safety work is based solely on the lack of application of these principles in an understanding manner.

In the first chapter Mr. Heinrich presents the fundamental principles of accident prevention, as (1) executive interest and support, (2) cause-analysis, (3) selection and application of remedy, and (4) executive enforcement of corrective practice. In succeeding chapters he takes up the applications of these principles to specific problems, citing numerous examples from his own wide experience and the experience of others. Such problems as education of employees, safety phychology, machine guarding, and illumination are dealt with, but always in the light of the co-ordinated fundamentals that furnish the foundation of the science of accident prevention. Other chapters deal with the cost of accidents and the importance of proper statistics, and the appendix gives details on how individual companies have promoted safe practices and controlled accident frequency.

The book is written in a clear and interesting style. Presenting as it does a coherent exposition of the whole subject of industrial accident prevention, it is a valuable contribution to literature on the subject.

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Brief Reviews

A.S.M.E. POWER TEST CODES—INSTRUMENTS AND APPARATUS—PART 17, DETERMINATION OF THE VISCOSITY OF LIQUIDS. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City; 28 pages; diagrams, charts, and tables; price, 45c.—A description of the instruments and apparatus available for measuring the viscosity of liquids.

INDUSTRIAL RESEARCH LABORATORIES OF THE UNITED STATES. Fourth edition of bulletin 81 of the National Research Council, Washington, D. C. 267 pages; price, $2. —A list of more than 1,600 laboratories engaged in industrial research in this country, with brief reference to the type of work done.

STREAM GAGING IN ARKANSAS FROM 1857 TO 1928. By W. S. Frame. Published by the Arkansas Geological Survey, 443-447 State Capitol, Little Rock, Ark.; 149 pages, illustrated; price, $1.90 cloth, $1.40 paper.—Contains information on stream flow, discharge measurements, gaging stations, and water-power developments in Arkansas from 1857 to 1928.

MECHANICAL WORLD ELECTRIC POCKET BOOK, 1931. Published by Emmott & Company, 65 King St., Manchester, England; 395 pages, illustrated; price 1/6 net.—New features of this ever useful handbook of electrical machinery include the latest practices in power-plant operation, electric railways, and lighting.

PROCEEDINGS OF THE A.S.T.M., 1930. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.; Part I, 1336 pages; Part II, 1085 pages; illustrations, charts, and tables; price each part, $6 paper, $6.50 cloth, $8 half-leather.—Part I contains the annual reports of 48 standing committees, research committees, and joint committees of the A.S.T.M., together with 58 tentative standards and tables of properties of materials. Part II contains 74 technical papers with discussion presented at the annual meeting of the society, held last June in Atlantic City.

STANDARDS YEARBOOK 1931. Compiled by the National Bureau of Standards of the Department of Commerce; miscellaneous publication No. 106; 399 pages; for sale by the Superintendent of Documents, Washington, D. C.; price, $1.—This is the fifth edition of an annual work that has proved indispensable to all interested in any phase of standardization in America and abroad. It is a reference book, summarizing and bringing up to date current standardization activities.

REPORT OF THE SAINT LAWRENCE POWER DEVELOPMENT COMMISSION. Published by the Saint Lawrence Power Development Commission, 2503 Graybar Building, New York City; 206 pages; maps, charts, and tables.—The full report submitted by the commission to the New York State Legislature on Jan. 15; it contains complete information on the commission's plan for the development of hydro-electric power on the St. Lawrence River.

FLUID METERS, THEIR THEORY AND APPLICATION—PART I. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City; 92 pages; diagrams, charts, and tables; price, $2.—The third revised edition of a reference work on fluid meters compiled by the A.S.M.E. Special Research Committee on Fluid Meters. It contains experimental and theoretical data on the subject, as well as practical instructions on the application of these meters.

THE FRIABILITY OF ILLINOIS COAL. By Cloyde M. Smith. Published as Bulletin No. 218 of the Engineering Experiment Station, University of Illinois, Urbana, Ill.; 24 pages, charts and tables; price, 15c.—Results of an investigation for the purpose of determining the friability of Illinois coal by applying the drop test to samples taken directly from the mines.

CORRECTION—The price of Kraft's "The Modern Steam Turbine," reviewed in the Feb. 3 issue, is RM 20, not RM 7.5 as listed, according to the publishers, VDI-Verlag.

Trends in Steam Turbine Development*

The present trends of steam turbine development are toward the use of higher steam temperatures and pressures, increased capacities at the various speeds and increased output from a single casing, the employment of better materials for turbine parts, higher efficiency over a wide range of load, and the development of binary fluids for use in turbines.

By A. G. CHRISTIE

Professor of Mechanical Engineering
Johns Hopkins University

ATTENTION has recently been directed to studies of the effect of higher steam temperatures, which present more difficult problems than pressure alone. Metals such as were formerly used in turbine construction develop undesirable properties at temperatures above 750 deg. F. Tensile strength and fatigue limits decrease rapidly at higher temperatures, and the tendency toward that indefinite elongation known as "creep" also increases. The limiting temperature in a steam turbine is therefore fixed by the properties of available metals.

Progress has been made by searching out those materials that may be used safely at the higher temperatures and by designing spindles, blades, casings, etc., to be sufficiently strong under such conditions. "Creep" cannot be entirely overcome, but parts may be designed so that the working stresses will lead to a rate of creep at the given high temperature that is within safe limits over a period of years. Certain designers have chosen this rate of creep as 0.01 per cent per year.

With this rate of creep and with materials now available, turbines can be built for steam temperatures up to 900 deg. F. with assurance of satisfactory operation, and units for 1,000 deg. F. can be constructed with every hope of successful operation throughout their useful life.

The application of higher steam temperatures will have a profound influence on future station design. Previously, turbines with no reheating were limited to initial steam conditions of 450 lb. per square inch and 750 deg. F. Higher pressures used with the same temperature result in an excessive moisture content at exhaust. A single-cylinder turbine of 68,000 kw. with no reheating has already been built for 650 lb. per square inch pressure and 825 deg. F. With 900 deg. F. steam temperature, the steam pressure may be raised to 750 lb. per square inch.

Steam conditions in future stations will probably be standardized as follows: with no reheat, 400 lb., 750 deg., and 700 lb., 850 deg.; while with one stage of reheat, 1,400 lb., 750 deg. F., and 2,000 to 2,500 lb., 900 deg. F. In the latter case two stages of reheat may be used if high efficiency is desired.

*Abstract of paper presented before the Midwest Power Engineering Conference, Chicago, Feb. 10-13, 1931.

Increased Capacities

The use of turbines of large rated capacities results in several economic gains. Floor space per kilowatt decreases with increasing size as shown in Fig. 1. This results in a smaller turbine room and lower building cost per kilowatt. Vertical-compounding has been introduced to provide a further saving in floor space. The weight per kilowatt decreases with increased ratings, and the weight of units that operate at 3,600 r.p.m. is less than units of the same rating at 1,800 r.p.m. Fig. 2 shows that the efficiency tends to increase with higher turbine capacities, though at a less rapid rate in the largest units. First cost per kilowatt, shown in Fig. 3, also decreases with increased capacity. The economic justification for the trend toward higher capacities is evident from a consideration of these data.

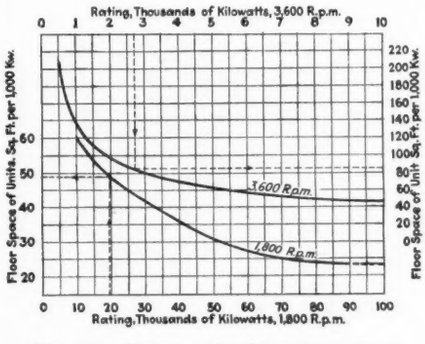
Rating, Thousands of Kilowatts, 3,600 R.p.m.
0 1 2 3 4 5 6 7 8 9 10
Floor Space of Units, Sq. Ft. per 1,000 Kw.
60 50 40 30 20
220 200 180 160 140 120 100 80 60 40 20
Floor Space of Unit, Sq. Ft. per 1,000 Kw.
3,600 R.p.m.
1,800 R.p.m.
0 10 20 30 40 50 60 70 80 90 100
Rating, Thousands of Kilowatts, 1,800 R.p.m.

Fig. 1 — Curves showing floor space occupied by 1,800 and 3,600-r.p.m. turbines

Single-cylinder condensing units of 10,000 kw. at 3,600 r.p.m. have been built in this country. C. A. Parsons & Co. have single-cylinder condensing units of 15,000 kw. at 3,600 r.p.m. in operation, one at Regina, Sask., and are offering similar turbines of 20,000 and 25,000 kw. with one casing. The largest unit at 1,800 r.p.m. with a single cylinder has a capacity of 80,000 kw. These single-cylinder units of high capacity pass such great volumes of steam through the last row of blades that the leaving losses are large. Such losses tend to offset the gain in engine efficiency which comes with increased size. American engineers, however, favor the single-cylinder units, because they decrease station cost and are simpler to operate.

Multi-cylinder units at 1,800 r.p.m. have been built in tandem up to 160,000 kw. Such tandem-compound units for large capacities are finding favor among power plant designers and will be used more extensively in the future. Triple-tandem turbines up to 150,000 kw. at 1,800 r.p.m. for 1,200 lb. per square inch are under construction.

Improved Materials

The manufacture of shafts and turbine disks has been improved through better steel-foundry and forge-shop practices, through internal inspection by means of bore holes, through vibrating the disks before assembly, and through careful static and dynamic balancing after completion. As a result of improvements in these practices, troubles with such elements are steadily diminishing.

Many turbine difficulties are traceable to blade troubles, and blade vibration is a common cause of failure. Much research work must still be done to find the proper location of lashing wires, the correct method of silver soldering these wires, the best form of shrouds, and even the most effective form, size, and angles of the blades themselves to resist vibration in the larger sizes of turbines now used.

Two trends in turbine development have been responsible for much blade trouble. To secure added capacity and improved efficiency, blade speeds have been steadily increased until tip speeds of 1,150 ft. per second are now in use. These operating conditions require long blades of high strength and rigidity. The second trend is the increasing use of large heat drops at high efficiency,

which lead to high moisture in the exhaust steam. Future developments will provide alloy steels for use at these high blade speeds which will have longer life under the wet steam conditions in the last rows.

Moisture is difficult to remove from this low-pressure steam. Different methods, such as drainage grooves, bypass orifices, etc., have been tried, but the best results so far reported indicate the removal of only about 25 per cent of the total moisture.

Of the various blade materials tried, properly heat-treated stainless steels and some nickel alloys seem best. Plating the edges of the blades with erosion-resisting metals has been tried, and heavy plating of chromium appears promising. Sprayed coatings of tantalum, sheathes of Hecla and other metals, coatings of stellite, and nitriding, also appear to resist erosion and are being further investigated.

A suggestion has been made to provide hollow stationary blades or hollow diaphragm partitions in which a hot medium can circulate. The heat from these blades would dry the low-pressure steam passing them. If this can be done, it will not only decrease erosion but will increase turbine efficiency.

Improved Efficiencies Over Wide Load Range

Efficiency in turbines is largely a matter of price. Each manufacturer offers units that will give about the same efficiency and will sell at about the same

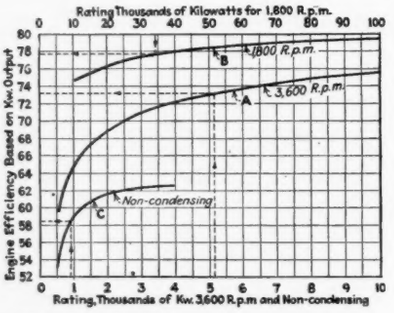

Fig. 2 — Turbine efficiency improves with increases in unit capacities

price as his competitors. Turbines of higher efficiency than these commercial units can be built if one is prepared to pay the higher cost of improved design. Load conditions, early supersession by more modern units, changing steam conditions, low fuel costs and other factors frequently make it uneconomical to purchase a turbine of the highest efficiency. Nevertheless the performance of steam turbines is being steadily bettered and this improvement will continue. Efficiencies of 82 to 85 per cent at the coupling are obtained on some American turbines, while an efficiency of 87.7 per cent at the coupling is claimed for a European turbine of 85,000 kilowatts.

Recent designs provide for high efficiency in B.t.u. per kilowatt-hour over a wide range of load through the use of secondary, tertiary, and even quaternary, inlet valves. In a recent large unit the

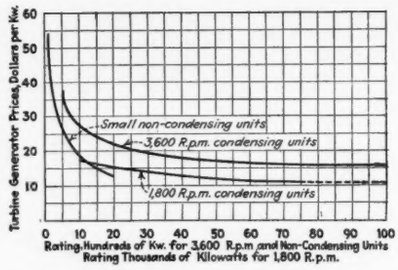
Turbine Generator Prices, Dollars per Kw.
Small non-condensing units
3,600 R.p.m. condensing units
1,800 R.p.m. condensing units
Rating, Hundreds of Kw. for 3,600 R.p.m and Non-Condensing Units
Rating Thousands of Kilowatts for 1,800 R.p.m.

Fig. 3—First cost of turbine generators decreases gradually as size of unit increases

heat consumption does not vary more than 100 B.t.u. per kilowatt-hour from 55,000 kw. to 115,000 kw.

Flue gas reheating is apparently gaining ground on account of the marked improvement in station economy achieved by its use. Steam reheating is more convenient in certain stations, but is less economical than gas reheating. The use of diphenyl-oxide for reheating purposes is being investigated and appears to have interesting possibilities.

Binary Fluid Turbines

The excellent performance of the mercury boiler and turbine-generator plant at Hartford, Conn., has definitely established that combination as a commercial unit. For ten months last year the plant operated at a heat rate of 10310 B.t.u. per kilowatt hour of net station output. Engineers expect ultimately to reduce this consumption to about 8,500 B.t.u. per kilowatt hour. The success of the mercury turbine will encourage attempts to develop processes to use other materials than mercury, such as diphenyl, diphenyl-oxide and zinc ammoniate. Some of these, or others yet untried, may prove suitable for power plant use.

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Over-All Efficiency of a Combination Pumping System

By E. C. KEEFE

IN last week's number of *Power* a question was discussed dealing with the combined over-all efficiency of a deep-well turbine and a horizontal centrifugal pump. The question assumed that the water horsepower was known, but none of the answers pointed out certain factors which must be considered in the solution.

In the assumption that there are at least two individual set-ups for the equipment in the above problem, I take the liberty to record formulas giving the desired quantity for each arrangement.

When the turbine pump discharge feeds directly into the centrifugal pump suction, *Water kw.* =

$$\frac{gpm \times 8.33 \times TDH \times SG \times 746}{33{,}000 \times 1{,}000}$$

and as the over-all unit per cent efficiency $= \dfrac{Water\ kw}{M_1 + M_2} \times 100$

$$= \frac{Water\ kw \times 100}{\dfrac{(P_1)}{(E_1)} + \dfrac{(P_2)}{(E_2)}}$$

$$= \frac{gpm \times TDH \times SG \times 8.33 \times 746}{33{,}000 \times 1{,}000} \times \frac{100}{\dfrac{(P_1)}{(E_1)} + \dfrac{(P_2)}{(E_2)}}$$

$$= \frac{gpm \times TDH \times SG}{\dfrac{(P_1)}{(E_1)} + \dfrac{(P_2)}{(E_2)}} \times 1.88 \times 10^{-2}$$

where gpm = Flow in gallons per minute.

TDH = Total dynamic head overall.

SG = Specific gravity of water at test temperature

M_1 = Kw. input to turbine pump motor.

M_2 = Kw. input to centrifugal pump motor.

P_1 = Brake horsepower of turbine motor as measured at flexible coupling.

P_2 = Brake horsepower of pump motor.

E = Motor efficiencies.

When the turbine pump discharges into an intermediate open tank, to which the centrifugal pump suction is connected: Over-all efficiency =

$$\frac{gpm\,[(TDH)_1 + (TDH)_2] \times SG}{\dfrac{(P_1)}{(E_1)} + \dfrac{(P_2)}{(E_2)}} \times 1.88 \times 10^{-2}$$

where $(TDH)_1$ = Total dynamic head of turbine pump.

$(TDH)_2$ = Total dynamic head of centrifugal pump.

Total dynamic head is the sum of static head, velocity head, friction, elbow and entrance losses. A good method of determination of total dynamic head on test is summarized in "Cameron Hyraulic Data," 1930, by Ingersoll-Rand.

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A NEW TRADE PUBLICATION, entitled *Wire Engineering*, has recently made its appearance. Published as a house organ by the John A. Roebling's Sons Company, Trenton, N. J., it is devoted to the technical and engineering aspects of wire rope, welding wire, flat wire, cables, copper and insulated wire. Those interested are requested to write to the company for copies of this magazine.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Selsyn-Operated Remote Indicating Pressure Gage

PRESSURE measurements of accuracy equal to those of the deadweight gage tester and permanence of calibration, together with unlimited power for the operation of indicators, recorders and control devices, are features of the new power-type pressure gage put out by the Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio. The device is, in effect, a deadweight gage tester combined with a hydraulic torque amplifier and a Selsyn motor system of long-distance transmission.

The power-type pressure device, a sectional view of which is shown in Fig. 1, is located near the pressure to be indicated or recorded. This pressure is applied by means of the connection at the bottom of the device to a small pressure piston which supports a pilot valve and a cup containing mercury. This portion of the pressure device is continuously rotated to eliminate static friction. The small motor which rotates the pressure piston pilot valve and mercury cup is also used to drive a small oil pump that provides the oil pressure required for operation of the power piston, displacer and Selsyn motor.

When the applied pressure increases or decreases, the pressure piston rises or falls proportionately, and in so doing permits oil under pressure to pass through the pilot valve to the upper or lower side of the power piston. If the pressure is increasing, the pressure piston, pilot valve and mercury cup rise, thus supplying oil presure to the upper side of the power piston. As the piston moves downward it forces the displacer deeper into the mercury, tending to force the mercury cup and pilot valve downward and return the pilot valve to its neutral position and so loose off the oil supply to the power piston. Consequently, for each pressure applied to the small rotating pressure piston, a definite position of the power piston and displacer is obtained.

A Selsyn motor driven from the rack on the power piston rod also assumes a definite position for each pressure, as does one or more Selsyn-operated indicators and recorders to which it is connected. Hence it is possible to secure accurate remote indications or records of the desired pressure.

It is pointed out by the manufacturer that, by varying the diameter of the pressure piston the size of the mercury cup and the size of the displacer, it is not only possible to furnish this power pressure unit for practically any maximum pressure, but also for a large suppression. The indicator shown in Fig. 2 permits of a total pressure range of only 30 lb. for an average operating pressure of 400 lb. Since this type of indicator is 42 in. in diameter, each division which represents a pound covers considerable space on the indicating scale, making accurate reading possible. The possibility of connecting as many as twelve or more indicators or recorders in the same master pressure circuit is an important feature of the instrument.

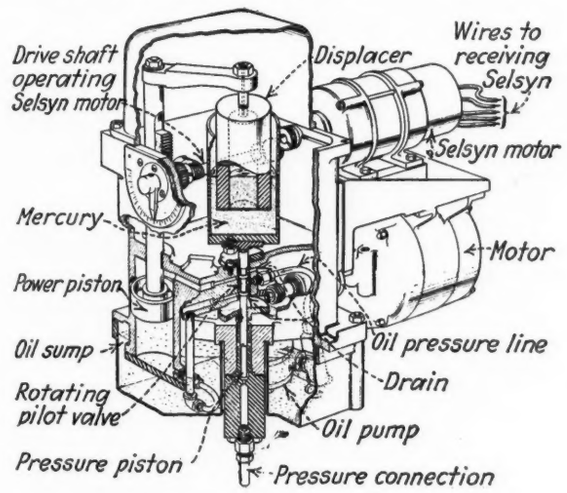


Fig. 1 — Cut-away view showing operating mechanism of the power type pressure unit

Fig. 2 — Large indicator with a total pressure range of 30 pounds

Chromium-Alloy Steel

A NON-CORROSIVE chromium-alloy steel is being produced by the Bethlehem Steel Company, Inc., Bethlehem, Pa., which has a yield point of 57,000 lb. per sq.in., a tensile strength of 90,000 lb. per sq.in., and a Brinell hardness of 174. When fully heat-treated, this alloy has a yield point of 158,000 lb. per sq.in., a tensile strength of 174,000, and a Brinell hardness of 352. It is available in ground bars, cold-drawn rods, heat-treated bars, forging billets, drop forgings, etc.

Inclosed-Design Variable-Speed Transmission

IN THE new inclosed-design variable-speed transmission recently brought out by the Reeves Pulley Company, Columbus, Ind., the standard internal operating parts are totally inclosed in a compact cast-iron case and are thus fully protected.

Ready access to the internal operating parts is provided by U-shaped recesses on the sides of the bottom sections of the case, which permits the removal, as a unit, of the operating parts, including the bearings of the two shafts as well as the shifting and

Above—Transmission with cover removed showing centralized lubrication. Below—Unit complete with motor base and driving motor

belt-tightening screws. Ready inspection of the parts, as well as minor adjustments or the installation of a new U-belt, is readily accomplished by removing a light lid from the cover section.

An outstanding feature of the new unit is the provision for the lubrication of all bearings by means of force-feed fittings in the recessed panels at one end of the transmission, as shown in the upper view. From these fittings rigid copper tubes lead to the four radial shaft bearings and flexible leads to the four thrust bearings at the disk hubs.

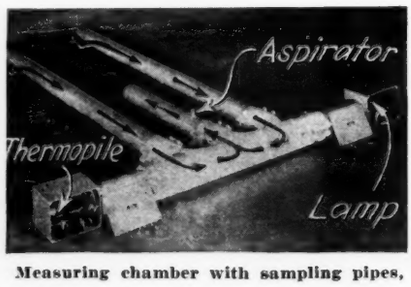
The cover section is also designed to accommodate adjustable motor rails and cross rails on which a complete motor unit or auxiliary countershaft unit may be mounted for varying requirements of machine speed control. These rails are bolted to each side of the cover outside the space occupied by the lid, previously referred to, leaving it free for removal.

Built in six sizes covering requirements from fractional to 10-hp. in all speed ranges, the new unit can be mounted on the floor, ceiling or in a vertical position, as the requirements of the installation demand.

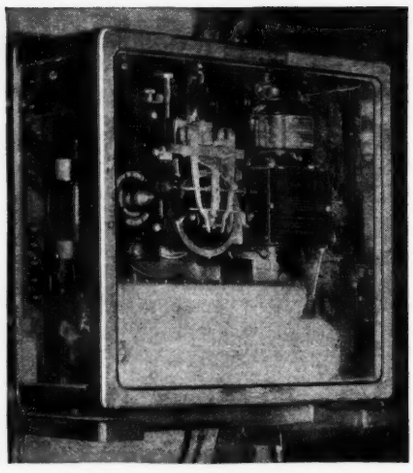
Smoke Density Recorder

TO PROVIDE a simple and practical means of measuring and recording the density of smoke continuously, Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., has developed the smoke recorder illustrated. The complete unit consists of a measuring chamber, a recorder and a boiler room indicator.

The measuring chamber is installed at some convenient place in the stack or breeching, with the sampling pipes shown extending into the smoke passage. Smoke is continuously drawn from the breeching, as indicated by the arrows, by means of an aspirator placed in the center pipe. This measuring chamber contains a lamp at one end and a temperature-compensated thermopile at the other as indicated. Heat radiated from the lamp passes through the smoke-filled chamber and falls on the thermopile, causing it to generate a voltage. With a constant heat source in the lamp the amount of heat passed to the thermopile is inversely proportional to the density of the smoke, hence the voltage generated by the thermopile is the measure of the smoke density. The recorder is a standard L. & N. potentiometer recorder that measures the voltage of the thermopile directly



Measuring chamber with sampling pipes,



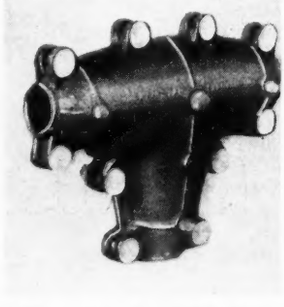
Instrument records per cent of smoke density

in per cent of smoke density or Ringelmann chart numbers.

The boiler room indicator (not shown) is a bank of five colored lamps that function continuously while the equipment is in operation, the color of the light burning indicating to the fireman the smoke condition in the stack.

Cable Splice Boxes

A LINE of splice boxes for all commercial cable sizes, either leaded, armored or trenchlay, in three styles, two-way splice, three-way tee (illustrated) and four-way cross, is



Three-way tee splice box

announced by the Delta-Star Electric Company, Chicago, Ill.

Boxes are furnished in plain gray iron, galvanized malleable iron or non-magnetic corrosion-resisting aluminum alloy for heavy duty alternating current. This improved design includes the following features: large and roomy interiors; large clamping bolts with square locking shoulders; ribbed bodies for extra strength; and separate end compartments adjacent to central section where armor or protective braid of cable can be terminated, each furnished with its own filling plugs.

NEWS of the FIELD

Program Announced for Annual Meeting of Welding Society in New York, April 22-24

Pressure piping code session and papers on welding of boilers and heat exchangers among features scheduled

WELDING OF PRESSURE PIPING and power equipment are prominent features of the program just announced for the annual meeting of the American Welding Society, to be held at the Engineering Societies Building in New York City on April 22 to 24 inclusive. Other features of the program include sessions on structural steel and industrial applications, the annual dinner, and an inspection trip on April 25 to a large medical center now under construction in the city.

The technical session on pressure piping, scheduled for Thursday afternoon, April 23, will be a joint meeting with the Pressure Piping Code Committee of the American Standards Association for the purpose of discussing a proposed section to the code covering the welding of pressure piping. This section will be presented by a subcommittee of the American Welding Society. As a supplement to the discussion, J. H. Zink, chairman of the committee on welding of the Heating and Piping Contractors National Association, will present a paper on "Welding of Heating and Industrial Piping."

Papers to be given on the welding of power equipment are: "Welded Boilers for the United States Navy Scout Cruisers," by J. C. Hodge of the Babcock & Wilcox Company, and "Fusion Welding as Applied to High-Pressure Heat Exchangers" by Marselis Powell of the Whitlock Coil Pipe Company. The first will be read at the morning session on April 22 and the second at the morning session on April 23.

Other papers include: "Welded Machinery Foundations for Ships," G. H. Moore, Jr.; "Some Examples of Welding in Structural Steel Work," D. C. Tennant; "Formulae for Eccentrically Welded Connections," Odd Albert; "Some Tests of Gas-Welded Structural Joints," H. H. Moss; "Some Resistance Welding Problems," C. L. Pfeiffer; "Strength and Characteristics of Various Types of Connections for Static and Dynamic Loadings," C. H. Jennings; "Thermit Welding in Maintenance in the Steel Mill," J. H. Deppeler; "Metal Arc Welding of Copper Alloys," Ira. T. Hook; "High Tensile Atomic Hydrogen Arc Welds in Alloy Steels," Frederick Ray.

Committee reports will be heard at the board of directors meeting, and, as usual, a session will be devoted to the meeting of the American Bureau of Welding, the research department of the society. Professor C. A. Adams, first president of the society, will preside, and the progress reports of the various research committtees will be read. Besides the annual "stag" dinner with special entertainment on Thursday evening, April 23, an interesting inspection trip to the New York Hospital and Cornell Medical Center has been arranged for Saturday morning, April 25. There members will be taken through the main building and power house where they will have an opportunity to observe the layout of the piping. This project involves over 50,000 ft. of welded pipe, ranging in size from 2½ to 24 in., for the transmission of hot water, brine, and steam for low-pressure and high-pressure service.

Former Senator Pepper to Defend Dr. Smith

GEORGE WHARTON PEPPER, former United States Senator and widely known constitutional lawyer, will defend Dr. George Otis Smith, chairman of the Federal Power Commission, in the suit brought by the Senate, it was announced last week.

Attorney General Mitchell issued a formal statement on April 2, taking issue with published comment that the Department of Justice would not be active in the defense of Dr. Smith. The Attorney General explained the technical reasons why he would appear as a friend of the court but stated that he would be in a position in that capacity to support as vigorously as he knows how the vadidity of the appointment.

To Call for New Bids on Hydraulic Laboratory

DUE TO SLIGHT ERRORS in the two low basic bids for the construction of the new hydraulic laboratory building at the Bureau of Standards, it has been decided to ask for new bids. The new bids will be opened on April 7. It was found when the bids were opened recently that the firm of Stofflet and Tilloston was the low bidder for a price of $303,900. The second low bidder was George E. Wyne, with a bid of $305,400. In analyzing these two low bids it was discovered that Stofflet and Tilloston did not specify the time for commencement and for completion and that George E. Wyne did not include unit costs.

Bids for the construction of nine sluice gates will be opened on April 10. Two of these gates will be 72x72 in. Two will be 72x84 in. Others will vary in size from 96-in. diameter to 60x60 in. and 36-in. diameter. It is also expected that in the near future bids will be embodied for pipes and pumping equipment.

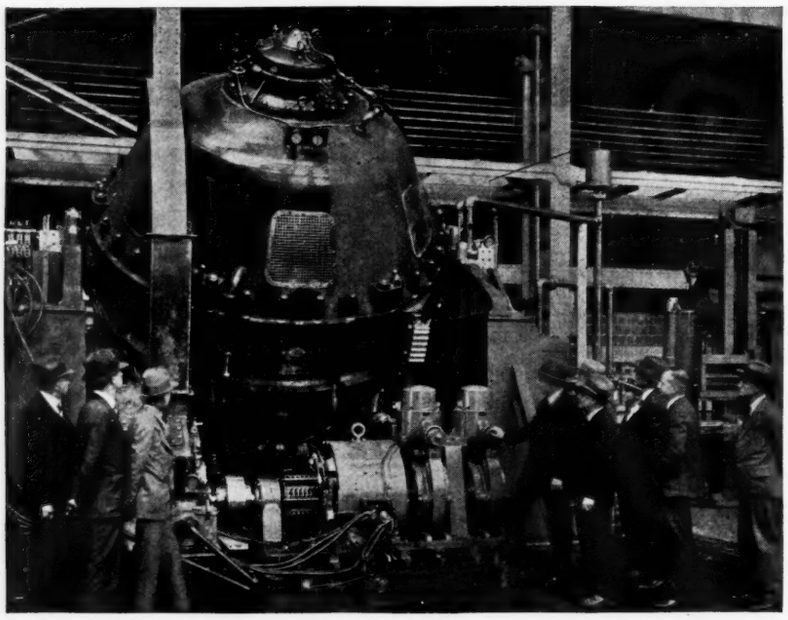
Hoover Dam Power Line Ahead of Schedule

ANNOUNCEMENT has just been made by the Nevada-California Electric Corporation that its two principal subsidiary power companies, The Southern Sierras Power Company and The Nevada-California Power Company, are ahead of schedule in the construction of their 230-mile steel-pole power line from San Bernardino to the site of the Hoover Dam. Forty-three per cent of the line from Victorville to the dam site, or 83 out of 193 miles, was completed on March 1, and it is expected that the line will be ready for operation by June 1 instead of June 25, the date set by the United States Department of the Interior.

E. J. Waugh, construction engineer for the power companies, announces that excavation for the terminal power substation at the site of the dam has been made, requiring the removal of 1,500 cu.yd. of solid rock.

Specification for the power house at the Hoover Dam and for its equipment probably will not be ready for a year, Dr. Elwood Mead, the commissioner of reclamation, announces. Inquiries concerning the power house are beginning to come in.

GIANT GYRO-STABILIZER ON TEST



An 11-ft. gyro-stabilizer, weighing 120 tons and designed for a foreign shipbuilder, was tested recently before prominent marine engineers at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company. Driven by a built-in 200-hp. motor, the 55-ton "top" spins at 930 r.p.m., requiring almost an hour to bring it up to this speed. The stabilizer is one of the largest ever constructed and requires a separate 360-kw. turbine-generator unit to operate it.

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Plan 160,000-Hp. Project On Columbia River, Wash.

UNIQUE in many respects is the plan of the newly formed Columbia River Power Company of Seattle, Wash., for developing 160,000 hp. on the Columbia River between Cascade Locks, Ore., and Stevenson, Wash., without a diversion dam. The general plan is outlined in the company's application for preliminary permit to the Federal Power Commission filed recently.

The scheme proposes to construct along the Washington shore of the river an open canal 6,500 ft. in length with its intake about a mile below Stevenson. This canal, which would be 300 to 400 ft. wide on the bottom and 75 to 90 ft. deep, would have its bed sufficiently low to divert most of the 90 per cent flow (about 90,000 sec. ft.). It would deliver water to five tunnels about 7,500 ft. long and 40 to 50 ft. in diameter which would discharge into a forebay, into one wall of which would be built the power house near the shore line of the river below the rapids. The difference in elevation between intake and tailrace is placed at 27 ft., which after losses in canal and tunnel would provide a 23-ft. net head on the wheels, or a capacity of 160,000 hp. 90 per cent of the time.

As a further development to be undertaken later the application states that it is contemplated to build a dam approximately 13 ft. high below the intake which will increase the capacity to 250,000 hp. 90 per cent of the time. The initial development is estimated to cost $15,000,000.

To Hold World Congress on Social Economic Planning

A WORLD INDUSTRIAL relations congress on "Social Economic Planning—The necessity for planned adjustment of productive capacity and standards of living" is announced by the International Industrial Relations Association, whose membership in 29 countries includes industrial executives, labor leaders, industrial relations consultants, economists, bankers and others actively concerned with "the study and promotion of satisfactory human relations and conditions in industry." The congress, the first of its kind, will be held at Amsterdam, Holland, during the last week of August.

Among the subjects to be discussed at sessions of the congress are "The Present Paradox—Unemployment in the Midst of Economic Progress," "Potentialities in National Economic Planning," "The Co-operative Movement in Industrial Relations," "The International Bank, Its Potential Relation to Planned Production," "The Necessity and Means for International Economic Planning," "The Problem of Planned Economy," "International Planning by Industries," "The Principles and Practice of Scientific Management," "Mass Distribution and Standards of Living."

Proceedings will be conducted in English, French, and German. To insure complete freedom of expression, it is announced that all participants in the congress will speak as individuals, not as representatives of their nations.

New York Assembly Passes St. Lawrence Power Bill

THE CORNAIRE BILL providing for the creation of a power authority to develop the hydro-electric resources of the St. Lawrence River was passed by the New York Assembly on March 31 by a unanimus vote and sent to the Senate. Debate on the bill centered around amendments proposed by the minority to carry out Governor Roosevelt's recommendation that the power authority should consist of full-time salaried members instead of part-time members as provided in the bill. The amendments were defeated by a vote of 80 to 70.

On April 2 the Senate Finance Committee reported out the bill with an amendment providing for the appointment by the legislature of the first five members of the power authority, as follows: Robert M. Haig, Julius H. Cohen, Samuel L. Fuller, Frederick M. Davenport, and Thomas F. Conway. Governor Roosevelt denounced the amendment as a move on the part of Republican leaders to force him to veto the bill, thereby shelving action on the project for another year.

On March 31 the Assembly also passed and sent to the Governor the Knight bill creating a temporary state commission to act jointly with similar commissions of states adjoining New York to make a survey of utility companies engaged in interstate transmission of power, to formulate the terms of a treaty between such states and the federal government, and to recommend state and federal legislation necessary to regulate such interstate transmission.

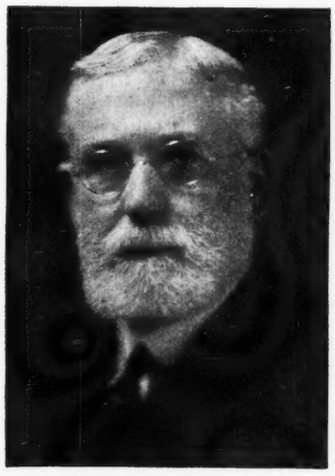
Seek Recall of Seattle Mayor on Ross Dismissal

WITH THE DISMISSAL of J. D. Ross as city light superintendent as the major issue, a recall campaign against Mayor Frank Edwards of Seattle, Wash., was formally started on March 30 by the Citizens' Municipal Utilities League. Recall petitions charge the Mayor with acts of malfeasance and violation of his oath of office, in that "on March 9 he filed reasons for the removal of J. D. Ross which were false and known by him to be false and unfounded at the time he made them and that in so doing he did not faithfully demean himself as Mayor." Providing sufficient signatures to the petitions can be obtained, which appears assured, recall will be placed before the voters at a special election.

C. S. Blake, Noted Boiler Insurance Authority, Dies

CHARLES SPAFFORD BLAKE, chairman of the board of the Hartford Steam Boiler Inspection & Insurance Company, died on March 31 at his home in Westerly Terrace, Hartford, Conn., after an illness of several months. In engineering and insurance circles, Mr. Blake was recognized as a national authority.

Born in Windsor Locks, Hartford, on Oct. 25, 1860, Mr. Blake early served an



Charles S. Blake

apprenticeship at the Central Iron Works of Jersey City, N. J., a firm that built engines and boilers. Before he was 21 he was licensed as an engineer and shortly afterward he was certified as chief engineer of ocean-going steamers. After considerable experience in marine engineering, he entered the boiler insurance field in 1884 as an inspector for the American Steam Boiler Insurance Company. In 1898 he joined the Hartford Steam Boiler Inspection & Insurance Company, and six years later was made supervising general agent. He was elected president of the company in 1916 and chairman in 1927.

For thirteen years Mr. Blake served as president of the Steam Boiler and Flywheel Service and Information Bureau and was a member of the administrative council of the American Uniform Boiler Law Society.

Byllesby Engineers Hold Annual Convention

ON MAR. 24 AND 25 in the Bal Tabarin, Hotel Sherman, Chicago, the engineering department of the Byllesby Engineering & Management Corporation held its sixth annual convention. Over 200 engineers responsible for the design and construction work of the various subsidiaries of the Standard Gas & Electric Company were in attendance.

H. W. Fuller, vice-president of the corporation and chairman at the various sessions, reviewed the construction work of the past four years, giving trends in cost and prospects under the reduced building schedule for the year to come. The general subject, economics of electric power systems, was covered by two groups of participants, one group covering the trends in design of the principal mechanical equipment of steam stations; the other group pointing out the trends in design of the electrical generating equipment, transmission lines, substations, and interconnection. A symposium in four parts was devoted to the economics of distribution systems.

Other papers dealt with factory expediting and inspection, the lighting of generating stations, standards of service, the effect of design and construction on insurance rates, specifications to govern the quality of construction for electrical work and for structural work, development of the scientific spirit by keeping in intimate touch with late innovations in the field and instituting research within the company. Intense interest was shown in a talk by C. W. Stone on the wonderful possibilities offered by the Thyratron in the economical distribution of electrical energy.

A high light of the convention was the banquet with its entertainment and music. H. E. Mason, a Chicago lawyer of note, as guest speaker, recounted some interesting experiences he had had as a traveler in Russia. E. L. Manning of the General Electric Company entertained with electronic demonstrations.

Complete 30,000-Kw. Steam Plant for Tokyo, Japan

A 30,000-KW. STEAM PLANT has been completed by the Nihon Electric Company at Tsurumi, near Tokyo, Japan. The plant, which will have an ultimate capacity of 70,000 kw., will be operated as an auxiliary to the water-power plant on the Kurobe River. The Nihon company has secured the right to supply electricity to Tokyo in competition with the Tokyo Electric Light Company.

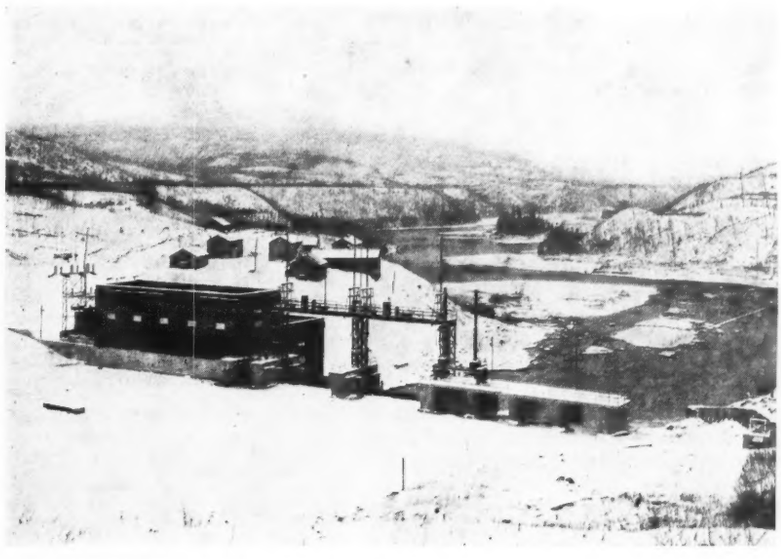
News of Canada

Large chemical industry may locate at Beauharnois—Upper Notch automatic plant completed

AT THE FIRST annual meeting of the Beauharnois Power Corporation, held in Montreal recently, announcement was made that arrangements have been nearly completed for locating a large chemical and metallurgical industry at Beauharnois, where construction is well under way on the 635,000-hp. development. President R. O. Sweezey stated that negotiations leading to the establishment of such an industry in the Beauharnois area had been carried on for some time, and if successful, they would take care of the surplus power available at the development. Mr. Sweezey further stated that contracts signed to date called for the delivery of 462,000 horsepower.

Reviewing the progress of construction on the project, Mr. Sweezey said that work on the power house is well advanced with more than 40,000 cu.yd. of concrete placed and two 8,000-hp. auxiliary turbines for plant use already installed. The first four 50,000-hp. waterwheels will be installed within the next two months and brick work on the superstructure of the power plant will begin shortly. The embedded parts for six additional 50,000-hp. units have been purchased and will be installed this spring.

ONE OF THE LARGEST fully automatic water-power plants in Canada was recently completed and placed in operation at Upper Notch on the Montreal River by the Northern Ontario Power Company. The installation in this plant consists of two 6,500-hp. Francis turbines operating at 125 r.p.m. under a 48-ft. head, direct-connected to two 6,500-kva., 11,000-volt, 25-cycle generators. The control apparatus in use at the plant is of the type known as "fully-



Recently completed automatic hydro-electric station at Upper Notch

automatic." Although as at present operated, the starting or stopping indication is given by an attendant who throws a small tumbler switch on the generator panel, the releasing of brakes, opening of turbine gates, bringing of the wheel to speed, matching of frequencies, and finally synchronizing and connecting to the line are fully-automatic and are beyond the control of the attendant until the full train of operations is completed.

A 110,000-volt transmission line, 32 miles long, ties the plant to the company's transmission network, which is fed by eight other hydro-electric stations aggregating 90,000 kva. The extensive transmission network to which the plant is tied serves the important mining areas of Timmins, Gowganda, Kirkland Lake, Cobalt, Rouyn, and other districts in northern Ontario and Quebec.

Purdue Studies Effect of Machine on Employment

STUDIES in technological unemployment are under way at Purdue University under the auspices of the American Engineering Council, public service body of the engineering profession. The unemployment inquiry, dealing with the displacement of workers by machines, aims to measure the influence of science and invention on the business cycle, and to point the way to economic adjustments conforming to the conditions created by the machine age.

How far machinery is responsible for swelling the ranks of the idle is a problem which must be solved by a disclosure of the actual facts, engineers say. Up to now there has been much theorizing in this field, but authoritative information, to promote the general attack on the causes of recurrent cycles of depression, is lacking.

The Purdue investigation is one of a series of activities planned by the American Engineering Council to meet "the pressing necessity for an attempt to place in balance those forces which, on the one hand, lead to excessive business activity, and, on the other, to sharp business recession."

Beverly L. Worden Dies

BEVERLY LYON WORDEN, president of the Cutler-Hammer Manufacturing Company, of New York and Milwaukee, died on March 28 at his home in West Orange, N. J., following an illness of several months. He was 60 years old. Mr. Worden was founder of the Worden-Allen Company of Milwakuee, which later became the Lackawanna Bridge Company and was purchased in 1924 by the Bethlehem Steel Corporation. He was a member of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, and the Western Society of Engineers.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual convention at Skytop Lodge, Skytop, Pa. May 25-27. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Spring meeting at the Athletic Club, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

National Association of Heating and Piping Contractors. Annual convention in Louisville, Ky., May 6-9. Chairman of convention committee, M. J. Chagnard, 419 West Jefferson St., Louisville, Ky.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

GEORGES CLAUDE, prominent French scientist and inventor, has been awarded the gold medal of the Cuban Geographical Society for his achievements on his scheme to generate electrical energy by making use of the difference in temperature between water at the surface of the ocean and water at great depths. Last year Professor Claude had his project in operation at Matanzas, Cuba.

FRANK G. FROST, superintendent of the electric department of the New Orleans Public Service Company, has been elected president of the Louisiana Engineering Society, succeeding JAMES M. TODD, consulting engineer. Other officers elected for 1931 are: vice-president, F. N. BILLINGSLEY, consulting engineer; secretary, FRANK A. MUTH, lighthouse engineer; and treasurer, WALTER B. MOSES, vice-president of the Engineering Sales Company. JAMES M. ROBERT, professor of machine design at Tulane University, has been appointed editor of *Proceedings* of the society to succeed DOUGLAS S. ANDERSON, dean of engineering at Tulane, who retired recently after editing the publication for sixteen years.

H. W. GREIDER has been appointed director of research for the Philip Carey Manufacturing Company. For several years he was the incumbent of the company's industrial fellowship on magnesia products at the Mellon Institute of Industrial Research. More recently he has been engaged in research and development work at the company's Plymouth Meeting, Pa., and Lockland, Ohio, plants.

HARRY C. CRONK has become associated with the Freyn Engineering Company and becomes a part of the group of Freyn engineers located at Leningrad, U.S.S.R. For the past three years Mr. Cronk has been electrical engineer of the Tata Iron & Steel Company at Jamshedpur, India. Prior to that time he was for many years electrical engineer of the McKinney Steel Company of Cleveland, Ohio. His brother, VANCE CRONK, has been associated with the Leningrad group of Freyn engineers for the past two years.

A. M. CHITTY, for the past five years manager of the southern district of the Puget Sound Power & Light Company in Washington, has been named manager of the southwestern district of the company, succeeding ROME C. SAUNDERS, who has been transferred to the company's executive offices in Seattle.

ALBERT H. WEHE has taken a position with the Hydro Engineering & Chemical Company of Elizabeth, N. J. ALBERT L. EIGENBROT has joined the staff of the M. W. Kellogg Company of Jersey City. Both are recent graduates of the course in fuel and gas engineering at the Massachusetts Institute of Technology.

Business Notes

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., reports "a fairly successful year in 1930, with earnings greatest in the history of the company, except for 1929." Profit available for dividends in 1930 amounted to $57,490,915, compared with $67,289,880 in 1929; orders received totaled $341,820,312, compared with $445,802,519 in 1929; and sales billed were $376,167,428, compared with $415,338,094 in 1929.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., reports that for the year ended Dec. 31, 1930, sales billed totaled $180,283,579, compared with $216,364,588 the previous year, and that profit available for dividends amounted to $11,881,705, compared with $27,062,611 in 1929. Unfilled orders as of Dec. 31, 1930, amounted to $40,208,181, compared with $62,025,399 for 1929.

ASHTON VALVE COMPANY, Cambridge, Mass., announces the election of Henry B. Nickerson as vice-president in charge of sales. Mr. Nickerson was formerly vice-president of the Consolidated Ashcroft Hancock Company, and prior to that with the American Schaeffer & Budenberg Corporation and the American Steam Gage & Valve Manufacturing Company.

THERMOID RUBBER COMPANY, Trenton, N. J., announces that John H. Kelly has joined its staff. Mr. Kelly was formerly president of the Hewitt Rubber Company, and when this firm entered the Gutta-Percha Rubber Manufacturing Company-Robins Conveying Belt Company merger, he assumed the vice-presidency in charge of sales. Since 1928, when Mr. Kelly was forced to retire from active duty due to a serious illness, he has been doing special counselling work.

MANISTEE IRON WORKS COMPANY, Manistee, Mich., announces the appointment of P. H. York, 1002 East Washington St., Indianapolis, Ind., as its representative in the Indiana territory, and the Malsby Machinery Company, P. O. Box 335, Perry, Fla., as its representative in Florida.

BERNITZ FURNACE APPLIANCE COMPANY, New York City, announces the following changes in sales personnel: Benjamin H. Snow has been appointed division sales manager for territory including the New England states, New York, and northern New Jersey; L. R. Leatherman has been transferred to the New York Office; and F. G. Schneeberg, Jr., associated with Mr. Leatherman, will handle sales in upper New York and northern New Jersey.

RAY BURNER COMPANY, San Francisco, Calif., announces that the Bell & Gossett Company, 3000 Wallace St., Chicago, Ill., has been appointed to take over the management of the Ray factory branch in that city.

WITH THE SOCIETY SECTIONS

A.S.M.E., Anthracite-Lehigh Valley Section. Meeting and exhibition at the Hotel Altamont, Hazelton, Pa., on Saturday afternoon and evening, April 18. General subject: "Practical Industrial Lubrication." A large number of manufacturers are expected to exhibit small lubricating devices and equipment. Manager, C. W. Bell, 177 East Broad St., Hazleton, Pa.

A.S.M.E., Baltimore Section. Joint meeting with the Baltimore Sections of the A.I.E.E. and A.S.C.E. and the Baltimore Engineers Club at the Pennsylvania Water & Power Company, Holtwood, Pa., on April 23. Subjects: "Holtwood Hydraulic Laboratory and Its Contribution to the Design of the Safe Harbor Development," by G. W. Spaulding, Pennsylvania Water & Power Company; "Construction of the Safe Harbor Development," by C. W. Black, The Arundel Corporation.

A.S.M.E., Los Angeles Section. Afternoon and evening inspection trip to Los Angeles Harbor and Long Beach steam station on April 18. Evening meeting at Long Beach.

A.S.M.E., Metropolitan Section. Meeting in the Engineering Societies Building on April 29 at 8 p.m. Subject: "Developments of the Stationary Diesel Engine Under the Conditions of American Power Economics," by Julius Kuttner, editor of *Diesel Power*.

A.S.M.E., New Haven Section. Meeting at Mason Laboratory, Yale University, on April 24 at 8 p.m. Subject: "Internal Combustion Engines," by Professor L. C. Lichty, Yale University.

N.A.P.E., New England Association. Annual convention at Worcester, Mass., June 18-20. Secretary, W. B. Powers, 498 Green St., Cambridge, Mass.

Trade Catalogs

INSTRUMENTS — A full, illustrated description of the construction, operation, and installation of Brown electric CO_2 meters is given in Catalog No. 3004 recently published by the Brown Instrument Company, Philadelphia, Pa.

BAFFLE WALLS—Engineering data on boiler baffle walls is contained in an illustrated folder entitled "The Beco-Turner Baffle Wall," the first publication of the Boiler Engineering Company, 24 Commerce St., Newark, N. J., since its affiliation with the Plibrico Jointless Firebrick Company of Chicago.

VALVES — Pressure reducing and regulating valves are described and illustrated in a folder recently issued by the Watts Regulator Company, Lawrence, Mass.

BOILER NOZZLES—The Lenape Hydraulic Pressing & Forging Company, Lenape (West Chester), Pa., has just issued a new folder covering its "Red Man" forged-steel boiler nozzles. The folder decribes the construction features of the nozzles and points out the economies effected by their use.

INSTRUMENTS — The Taylor Instrument Companies, Rochester, N. Y., have just isused the 1931 edition of their catalog covering "Tycos Instruments for Steam Power Plants." Included in this publication are illustrated descriptions on many types of indicating and recording thermometers, vacuum and pressure gages, pyrometers, pressure and temperature regulators, U-gages, and valves. The catalog contains a diagrammatic layout of a power plant, showing the application of the various instruments.

VALVE SPECIALTIES—Davis Regulator Company, 2541 South Washtenaw Ave., Chicago, Ill., is issuing a six-page folder descriptive of the various automatic valve specialties made by the company for pressure and flow control.

Fuel Prices

FUEL OIL

Boston—March 30, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.9c. per gal.

New York—April 2, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—March 23, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—April 1, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c@3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Cincinnati—March 31, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—March 20, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 50c. per bbl.; 22@24 deg., 55c. per bbl.; 24@26 deg., 60c. per bbl.; 26@28 deg., 70c. per bbl.; 28@30 deg., 80c. per bbl.

St. Louis—March 24, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.295 per bbl., or 42 gal.; 26@28 deg., $1.395 per bbl.; 28@30 deg., $1.495 per bbl.; 30@32 deg., $1.595 per bbl.; 32@36 deg., gas oil, 3.526c. per gal.; 38@40 deg., distillate, 4.026c. per gal.

Dallas—March 28, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.00
Smokeless, slack	Chicago	.75 @ 1.35
Harlan, Ky., slack	Chicago	.70 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.90 @ 1.25
W. Ky., slack	Louisville	.75 @ .90
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.00
Smokeless, slack	Cincinnati	1.00 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.75 @ 1.00

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles — Los Angeles Gas & Electric Co., 810 South Flower St., will build a sub-station on West 36th St. Estimated cost $60,000. Private plans. Work will be done by day labor.

Calif., Pasadena—City received lowest bid for steam turbine electric generator for municipal power plant from Allis-Chalmers Mfg. Co., 458 South Spring St., Los Angeles. $400,000 to $423,000.

Calif., San Francisco—Ninth and Market Co., A. F. Rousseau, Agt., 110 Sutter St., is having preliminary plans prepared for the construction of a theatre, hotel and apartment building at 9th and Market Sts. Estimated cost $10,000,000. D. A. Stone, 337 17th St., Oakland, is architect.

Colo., Grand Junction—City, H. C. Tomlinson, Clk., plans an election April 7 to vote $750,000 bonds for the construction of a power plant. Wood & Weber, 110 14th St., Denver, are engineers.

Colo., Pueblo—J. W. Field and A. D. Field, 36 West 59th St., Kansas City, Mo., c/o J. F. Codding, Rye, plan the construction of a sanitarium and health resort, including hydro-electric plant, dam, lake, sawmill, etc.

Conn., Bristol—Connecticut Light & Power Co., Riverside Ave., is receiving bids for a 3 story, 60 x 60 ft. central heating plant including oil burners, storage tanks, etc., on Riverside Ave. Estimated cost to exceed $40,000. H. A. Hayden, 175 Main St., is engineer.

Ind., Auburn—School Commissioners, are receiving bids for improvements to power plant, including water supply service, hot water heater. Estimated cost $50,000. Pohlmeyer & Pohlmeyer, 260 Central Bldg., Fort Wayne, are engineers.

Ind., Auburn—U. G. Souder, had plans prepared for addition to power plant for hospital. Estimated cost $40,000. Le Roy Bradley, 221 West Wayne St., Fort Wayne, is engineer.

Me., Portland—Portland Water District, will soon award contract for the construction of a pumping station on Walnut St. J. C. and J. H. Stevens, 711 Chapman Bldg., are engineers.

Mass., Barnstable—Cape Cod Gas Co., P. P. Crafts, Secy., 1 State St., Boston, is receiving bids for the construction of an illuminating gas plant here. Estimated cost to exceed $40,000. Private plans.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., awarded contract for excavation and will soon take bids on superstructure for steam heating plant at Kneeland and Utica Sts. to A. G. Tomasello & Son Inc., 250 Stuart St., $25,000.

Mass., Holyoke—Holyoke Water Power Co., R. E. Barrett, Pres., is having plans prepared for the construction of a hydro-electric plant. Estimated cost $500,000. R. A. Smith, 1 Canal St., is engineer.

Mass., Reading—Dept. of Public Works, is having plans prepared for the construction of a pumping station near Grove St. Estimated cost $50,000. Weston & Sampson, 14 Beacon St., are engineers.

Mass., Worcester—Worcester County Commission, E. W. Glidden, Court House, is having plans prepared for the construction of a group of buildings for sanitorium to include hospital, nurses' home, service building and power plant, at Huntington Farm. Estimated cost $1,000,000. Frost, Chamberlain & Edwards, 390 Main St., are architects.

Mich., Detroit—Dept. of Water Supply, G. H. Fenkell, 735 Randolph St., Gen. Mgr., received lowest bid for the construction of a power plant and switch house at Springwells Station, water supply system from W. E. Wood, Union Trust Bldg., $983,320.

Mo., Leeds—American Refrigerator Transit Co., Missouri Pacific Bldg., St. Louis, is having preliminary plans prepared for the construction of a 2 story car icing plant to include ice manufacturing plant, ice warehouse, icing docks, etc. Estimated cost $350,000. E. A. Hadley, c/o owner, is engineer.

Mont., Forsyth—City will soon award contract for the construction of a pumping and filtration plant. Estimated cost $50,000. F. F. Palmer is city engineer.

Neb., Fremont—Fremont Fuel & Ice Co., 250 West 5th St., will build a 1 story, 36 x 65 ft. ice house on Sixth St. Work will be done by day labor. Equipment to cost $45,000 will be required. Refrigeration machinery let to Baker Ice Machine Co., 3601 North 16th St., Omaha.

N. H., Portsmouth—Dept. of Public Works, City Hall, had plans prepared for the construction of a hot asphalt plant, including motors, mixer, pug mixer, bins, elevator, screens, kettle, 1000 gal. capacity heater, pump and dryer. Estimated cost to exceed $40,000. Private plans.

N. J., Convent Station—Fanning & Shaw, 49 Ward St., Paterson, Archts., are receiving bids for the construction of a 68 x 95 ft. power house for St. Elizabeths' College, Sisters of Charity. Estimated cost $40,000.

N. Y., Brooklyn—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for a turbo-alternator set at Navy Yard here to Moore Steam Turbine Co., Wellsville, N. Y. Estimated cost $30,000.

N. Y., New York—Dept. of Hospitals, Municipal Bldg., will receive bids about May 15 for addition to boiler house and stack at Welfare Island. W. H. Gompert, 101 Park Ave., is architect. K. M. Murchison, 101 Park Ave., is engineer.

O., Berea—Bd. of Public Affairs, awarded contract for a 100 kw. steam generator to Westinghouse Electric & Mfg. Co., Grant Bldg., Pittsburg $30,350; also condenser with auxiliaries to Foster-Wheeler Corp., Carteret, N. J. $8,930.

Okla., Fairfax—City, O. T. Corwin, Clk., plans a new election soon to vote $120,000 bonds for the construction of a municipal power plant and equipment. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, are engineers.

Pa., Pittsburgh—Stone & Webster, Union Trust Bldg., Supervising Engrs., are receiving bids for foundation and structural steel for a 12 story hospital on Darragh St. for Presbyterian Hospital, J. McA. Duncan, Chn. Bldg. Comn., 340 Highland Ave. Estimated cost $2,000,000. E. P. Mellon Koppers Bldg., Pittsburgh, and W. L. Smith, 350 Madison Ave., New York, are architects.

Tenn., Memphis—U. S. Veterans Bureau, awarded contract for the construction of a boiler house, etc., to Harrison Wright Co., Charlotte, N. C. $88,944.

Texas—Continental Construction Co., c/o G. Siedhoff, Contrs., will start work at once on the construction of a compressor plant to consist of twelve units of 1,250 hp. each, this will provide pressure through 1,000 miles of natural gas pipe between Texas Panhandle and Oklahoma, Kansas, Nebraska, Iowa and Chicago. Insull Interests and Subsidiaries of New York and Chicago are owners.

Wash., Seattle—Bd. of Public Works, will soon award contract for sewage treatment work including three pumping stations. Estimated cost $190,000. R. H. Thomson, Seattle, is engineer.

Wis., Milwaukee—H. E. Thwaits, is receiving bids for a 15 story apartment building including steam heating and refrigeration systems, elevators, etc. Van Alyes & Spintii, 408 Albion St., are architects.

Ont., Durham—Town, H. C. Rose, Clk., will soon award contract for waterworks improvements including reservoir and pump house, electric pumps, etc. Estimated cost $28,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers.

Equipment Wanted

Boilers—Boston, Mass.—Metropolitan District Commission, Water Division, 20 Somerset St., will receive bids until April 16 for three vertical fire-tube boilers 98 in. diameter and 24 ft. high, steam pressure, 185 lb. per sq.in.

Engine—Dorchester (sta. Boston) **Mass.**—Freeport Engine Co., 450 Freeport St. plans to purchase 8 cylinder Sterling engine.

Engine—Logan, Utah—Electric Light Dept., is receiving bids for a 600 kw. Diesel engine for municipal electric light plant. Estimated cost $65,000.

Generator—Brooklyn, N. Y.—Signal Supply Officer, New York General Depot, Army Base, will receive bids until April 14 for a motor generator.

Generator—Columbus, O.—Bd. of Trustees, Ohio State University, C. E. Steeb, Secy., plans to purchase a 4,000 kw. turbo generator, and 5,000 sq.ft. horizontal two-pass condenser.

Ice Plant Equipment—Nashville, Tenn.—Atlantic Ice & Coal Co., 916 4th Ave. N., plans the installation of new equipment for plant. $25,000.

Panels, Switchboards, etc.—New Orleans, La.—Sewerage and Water Board, will receive bids until April 25 for four control panels with instruments and accessories, four removable truck type switchboards for motor driving vertical trash pumps at drainage pumping stations, 6 and 7. Cont. 122-D.

Pump—Gardner, Mass.—Bello Corp., plans to purchase an electrically driven vacuum condensation pump for 5,000 ft. radiation.

Pumps—Fresno, Calif.—City H. S. Foster, Clk., is receiving bids for furnishing and installing three deep well turbine pumps in connection with waterworks.

Pumps, Turbine, Etc.—San Bernardino, Calif.—City Council, will receive bids until April 14 for a 2,700 g.p.m. booster pump and 2,700 g.p.m. deep well turbine pump both with direct connected motor, also 675 g.p.m. deep well turbine with water wheel and direct connected motor for proposed waterworks improvements.

Industrial Projects

Ind., Bloomfield—Harrah Mfg. Co., manufacturers of tools, awarded contract for a 1 story, 50 x 115 ft. factory at Spring and Jefferson Sts. to L. O. Cooper, Bloomfield. Estimated cost $42,000.

Ind., Indianapolis — G. J. Mayer Co., 36 South Meridian St., awarded contract for addition to factory for the manufacture of stamps at Liberty and Market Sts. to W. Van Landingham, Lemcke Bldg. Estimated cost $40,000.

La., Baton Rouge—Louisiana Creamery Co., Inc., will soon award contract for the construction of a 2 story creamery plant including cold storage plant, mechanical equipment, etc. Estimated cost $50,000. Weiss, Dreyfous & Seiferth, Maison Blanche Bldg., New Orleans, are engineers.

Mass., South Lee—Dwight D. Hopkins Lumber Co., will build a 1 story, 60 x 160 ft. woodworking plant. Estimated cost $75,000 including equipment. Work will be done by owners' forces.

Mass., New Bedford—Continental Wood Screw Co., 459 Mount Pleasant St., will build a 2 story, 50 x 100 ft. addition to factory. Estimated cost $45,000. Private plans. Work will be done by owners' forces.

Mo., St. Louis—J. R. Kearney Corp., 4320 Clayton Ave., awarded contract for a 3 story, 100 x 105 ft. addition to plant for the manufacture of underground and overhead electrical equipment and safety tools for handling high tension wires to Humes-Deal Co., 777 Arcade Bldg.

N. J., Ridgefield Park—Continental Paper Co., River Rd., Bogota, awarded contract for the construction of two buildings for paper plant here to Claus, Ahrens & Co., Inc., 72 Uhlandt St., East Rutherford. Estimated cost $40,000.

N. Y., Jamaica—Aluminate Co., Hillside Ave., will build a manufacturing plant at 132nd Ave. and 91st St. Estimated cost to exceed $40,000. H. T. Jeffery, Jr., 90-50 Parsons Blvd., is architect. Work will be done by day labor and separate contracts.

O., East Liverpool—C. C. Thompson Pottery Co., awarded contract for the construction of a 2 story, 50 x 150 ft. pottery plant to Potters Lumber Co., $50,000; also 135 ft. Robertson type tunnel kiln to H. L. Dixon Co., Rosslyn Rd., Pittsburgh. $40,000.

Pa., Pittsburgh—Mayer Body Co., W. G. Mayer, Pres., 6459 Frankstown Ave., awarded contract for two additions to plant, 1 story, 30 x 100 ft. and 2 story, 50 x 100 ft. to Edward Crump, Jr., 4031 Bigelow Blvd. Estimated cost $40,000.

Pa., Pittsburgh—Smith Faris Co., R. I. Smith, Pres., 1150 Hodgkiss St., manufacturers of asbestos, awarded contract for a 1 story, 26 x 82 ft. plant to A. Phillip, 3122 Brighton Rd. N. S. Estimated cost $40,000.

S. C., Anderson—Appleton Mills, will soon award contract for addition and alterations to textile mill. Estimated cost to exceed $150,000. Sirrine & Co., Greenville, are engineers.

Texas—Amarillo Producers & Refiners Association, c/o J. D. and J. Wrather, Amarillo, is having preliminary plans prepared for the construction of a refinery at Overton, also at Longview. Estimated cost $100,000 and $150,000 respectively.

Tex., Bryan—Stevenson Machinery Co., plans reconstruction of plant recently destroyed by fire to include machinery for assembling equipment, etc. Private plans.

Tex., San Antonio—Hydro-Plant Corp., D. J. Little, Pres., c/o L. E. Rush, Western Life Insurance Bldg., acquired a site and plans the construction of a plant for the manufacture of hydraulic auto brakes and other hydraulic machinery, also hydraulic pumps to include automotive department, machine and tool department, pump manufacturing department, etc. Estimated cost $500,000.

Tex., Texas City—Republic Oil & Refining Co., Houston, plans the construction of an oil refinery here. Estimated cost $1,000,000.

Tex., Tyler—G. Constantine, 1330 Terrace Dr., Tulsa, Okla., plans the construction of a skimming plant, 6000 bbls. daily capacity, near oil refinery plant here. Estimated cost $400,000. Private plans.